

 *Allen-Bradley*

Medium Voltage AC Drive

Bulletin 1557

User Manual

**Rockwell
Automation**

Important User Information

Read this document and the documents listed in the Additional Resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.



WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.



SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.



BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.



ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

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Manual Objectives

This manual is intended for use by personnel familiar with Medium Voltage and variable speed solid-state drive equipment. The manual contains material which will allow the user to operate, maintain, and troubleshoot the drive system.

IMPORTANT USER INFORMATION

Because of the variety of uses for this equipment and because of the differences between this solid-state equipment and electromechanical equipment, the user of and those responsible for applying this equipment must satisfy themselves as to the acceptability of each application and use of the equipment. In no event will Rockwell Automation be responsible or liable for indirect or consequential damages resulting from the use or modification of this equipment.

The illustrations shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Rockwell Automation cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

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Warnings tell readers where people may be hurt if procedures are not followed properly.



Cautions tell readers where machinery may be damaged or economic loss can occur if procedures are not followed properly.

Both of these:

- Identify a possible trouble spot.
- Tell what causes the trouble.
- Give the result of improper action.
- Tell the reader how to avoid trouble.



This symbol alerts the user to a potential electrical shock hazard which exists on a component or printed circuit board.

REPAIR OR REPAIR/EXCHANGE PROCEDURE

For your convenience, Rockwell Automation and Rockwell Automation Global Technical Services(GTS), provide an efficient and convenient method of returning equipment eligible for repair or repair/exchange.

A Product Service Report (P.S.R.) number is required to return any equipment for repair. This may be obtained from your area Rockwell Automation Distributor, Sales Office or Area Support Division.

Return any equipment to be repaired to the Area Support Division nearest you. Be sure to reference the P.S.R. number on the carton and packing slip. Include your company name and address, your repair purchase order number, and a brief description of the problem. This will facilitate quick return of your equipment.

A complete listing of Global Technical Services offices may be obtained by calling your area Rockwell Automation Distributor or Sales Office.

The Bulletin 1557 drive is a Pulse Width Modulated Current Source Machine side converter (PWM - CSI). It is designed to supply 3 phase currents to standard induction motor loads. The Bul. 1557 MV (medium voltage) drive converts 3 phase 50/60 Hz input power to an adjustable AC frequency current source for speed control of AC squirrel cage motors.

The solid state technology used in the design is of proven reliability. A number of circuit implementation techniques used are unique to the Allen-Bradley Bulletin 1557 drive.

The basic design philosophy emphasizes the isolation of single component failures, such that multiple component failures do not occur. This leads to a low MTTR, (Mean Time To Repair), with extensive fault diagnostic circuits and easy accessibility.

The basic design features of the Allen-Bradley Bulletin 1557 drive are as follows:

The three phase motor currents are sinusoidal with low total harmonic distortion.

The design uses isolated driver circuits, one per gate turn off thyristor (GTO), and silicon controlled line side converter (SCR).

Two output phases are individually current sensed, ensuring protection and control.

The design is capable of producing smooth low speed torque with low harmonic current to the motor.

A fuseless electronic protection scheme is used in the power circuit for normal fault conditions. Power fuses provide back up protection and ensure safety.

Heatsinks are monitored with temperature sensors to detect overtemperatures.
(BUL 1557 Air-cooled units only)

The 1557 Drive uses a North American design base with all components readily accessible from the front without need to extensively dismantle the unit.

The drive system logic is microcomputer based, thus eliminating numerous trim pots for system calibration.

Fault and alarm indication is performed using an operator interface panel.

An Input contactor with fused isolating switch is optional on the 1557 drive and is only supplied when specified or if the customer does not have an existing full voltage starter.

The standard 1557 drive is a tachless design. A tachometer is recommended for applications requiring an output frequency lower than 6 hertz or applications with a starting torque greater than 30%.

A drive isolation transformer or AC line reactor is required with each drive. An isolation transformer is mandatory when existing motors are used, 12-Pulse line side converters are used, or for stepping down the main supply voltage. An AC line reactor may only be used when new motors are used with the proper level of phase to ground insulation. Consult your Rockwell Automation representative for more information.

The electrical and environmental specifications of the Bulletin 1557 MV Drive are provided below:

Input Voltages:	2300Vac \pm 10%, 3-Phase 3300Vac \pm 10%, 3-Phase 4160Vac \pm 10%, 3-Phase 6900Vac \pm 10%, 3-Phase
Input Frequency:	50/60Hz \pm 3Hz
Efficiency:	97% at full load (minimum)
Output Voltage:	0 to 2300Vac, 3-Phase 0 to 3300Vac, 3-Phase 0 to 4160Vac, 3-Phase 0 to 6900Vac, 3-Phase
Output Frequency:	6Hz to 75Hz (Without Tach) 0.2Hz to 75 Hz (With Tach)
Speed Regulation:	0.5% of maximum speed (Without Tach) 0.1% of maximum speed (With Tach)
Speed Reference:	0 to 10V dc <i>or</i> 4 to 20 mA dc
Operating Temperature:	Ambient temperature must be within the range of 0° to 40°C with a relative humidity of up to 95% (non-condensing)
Storage Temperature:	Ambient temperature must be within the range of -40° to 70°C
Altitude:	No derating below 1000 m above sea level

Hardware Overview

The basic drive consists of two cabinets; the D.C. link/control cabinet and the converter cabinet. An input contactor cabinet is optional. (See Figure 4.1)

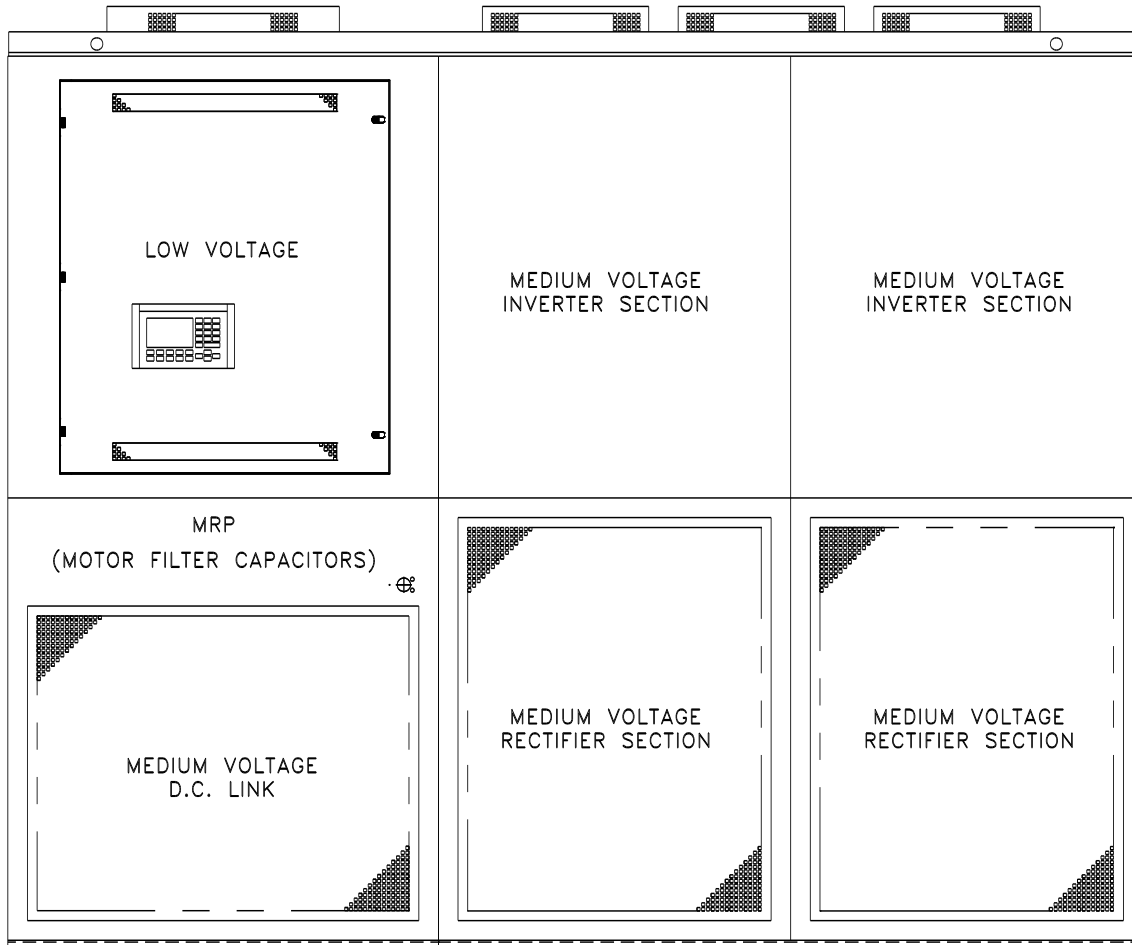


Figure 4.1 – Outline of 1557 Drive

DC Link Control Cabinet

The D.C. link/control cabinet is 44 inches wide. The top section has a panel with operator interface devices mounted on a door within a door. A fully vented door is in the bottom position.

Access to the low voltage control compartment is gained through the hinged low voltage panel.

All low voltage compartments contain the following elements:

- | | | |
|---------|-------------------------------|-----------------------------------|
| 4.2 (A) | Fiber optic interface boards | (2) |
| 4.2 (B) | Drive control boards | (2 for 6-pulse, 3 for 12-pulse) |
| 4.2 (C) | Communication processor board | (1) |
| 4.2 (D) | Digital I/O boards | (2) |
| 4.2 (E) | D.C./D.C. converter | (1) |
| 4.2 (F) | A.C./D.C. power supply | (1) |
| 4.2 (G) | Capacitors | |

See Figure 4.2

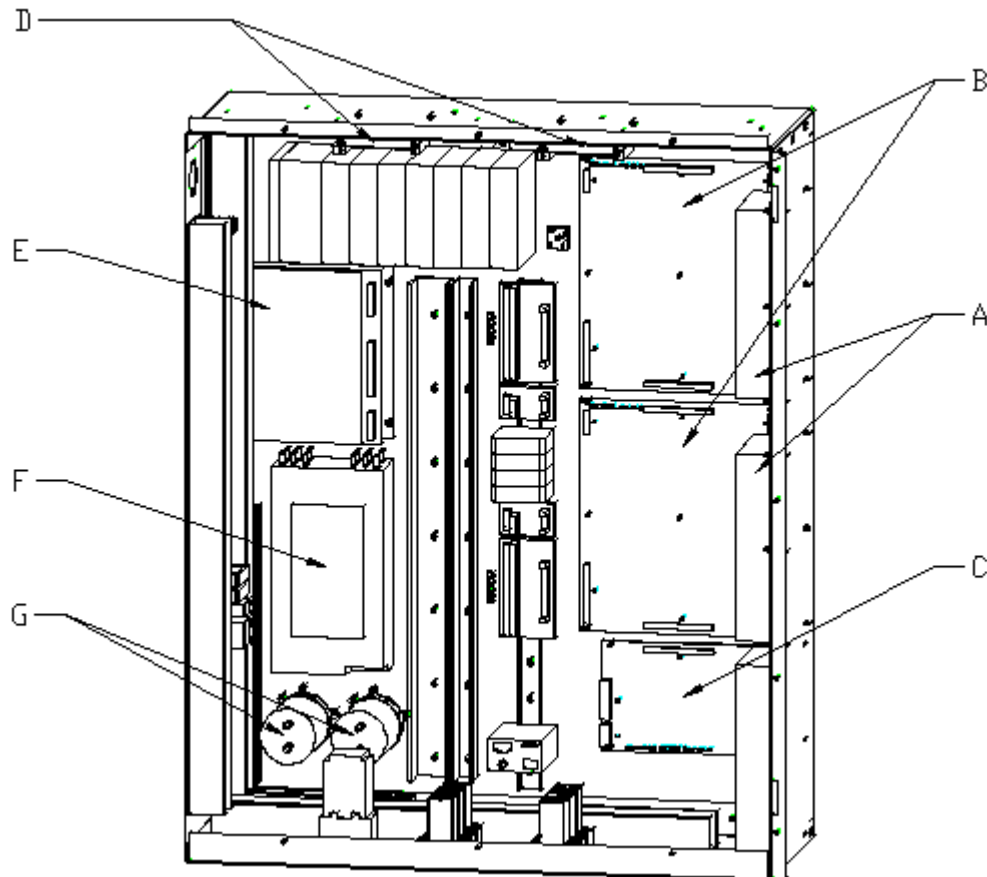


Figure 4.2 – Typical Low Voltage Compartment

D.C. Link Reactor

The D.C. link reactor is floor mounted and may be shipped separately and installed on site in larger drives.

Motor Filter Capacitors

Located behind the low voltage compartment, the motor filter capacitors are accessible when the upper medium voltage door is opened. There are 3 capacitors for low horsepower drives and 6 for larger drives. The capacitors are liquid filled and mounted on rails. The metal cases of the capacitors are grounded to the cabinet.



Warning: Allow 5-10 minutes for motor filter capacitors to safely discharge voltage prior to opening cabinet doors.

Line side converter Components

The line side converter is located in the lower half of the converter cabinet. The line side converter consists of three identical cells; each cell consists of the following:

- 4.3 (A) -line side converter heatsink stack
 - Silicon Controlled Line side converter (SCR) thyristors
 - heatsinks
 - clamp
 - 4.3 (B) -snubber capacitors
 - 4.3 (C) -snubber resistors
 - 4.3 (D) -voltage sharing/diagnostic resistors
 - 4.3 (E) -gate driver circuit boards
 - 4.3 (F) -power supply boards
- (See Figure 4.3)

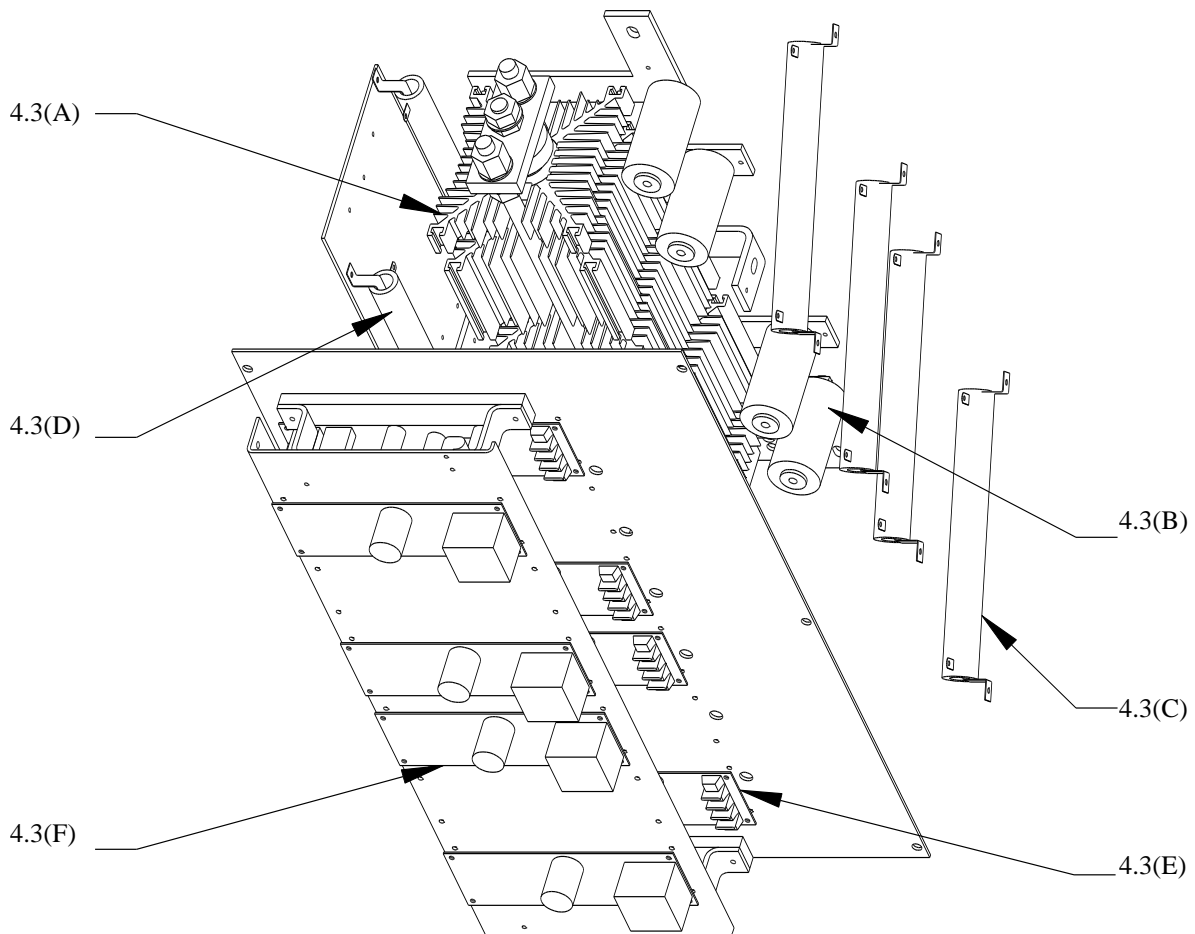


Figure 4.3 – Line Side Converter Components
(2300 V Line Side Converter shown)

Machine side converter Components

The machine side converter is located in the upper half of the converter cabinet. The machine side converter consists of three identical cells. each cell consists of the following:

- 4.4 (A) -machine side converter heatsink stack assemblies
 - Gate Turn Off (GTO) thyristors
 - heatsinks
 - clamp
 - 4.4 (B) -snubber resistors
 - 4.4 (C) -snubber capacitors
 - 4.4 (D) -snubber diode assemblies
 - Fast recovery diode
 - diode clamp
 - snubber capacitors for the snubber diodes
 - snubber resistors for the snubber diodes
 - 4.4 (E) -voltage sharing/diagnostic resistors
 - 4.4 (F) -gate driver circuit boards
 - 4.4 (G) -power supply boards
- (See Figure 4.4)

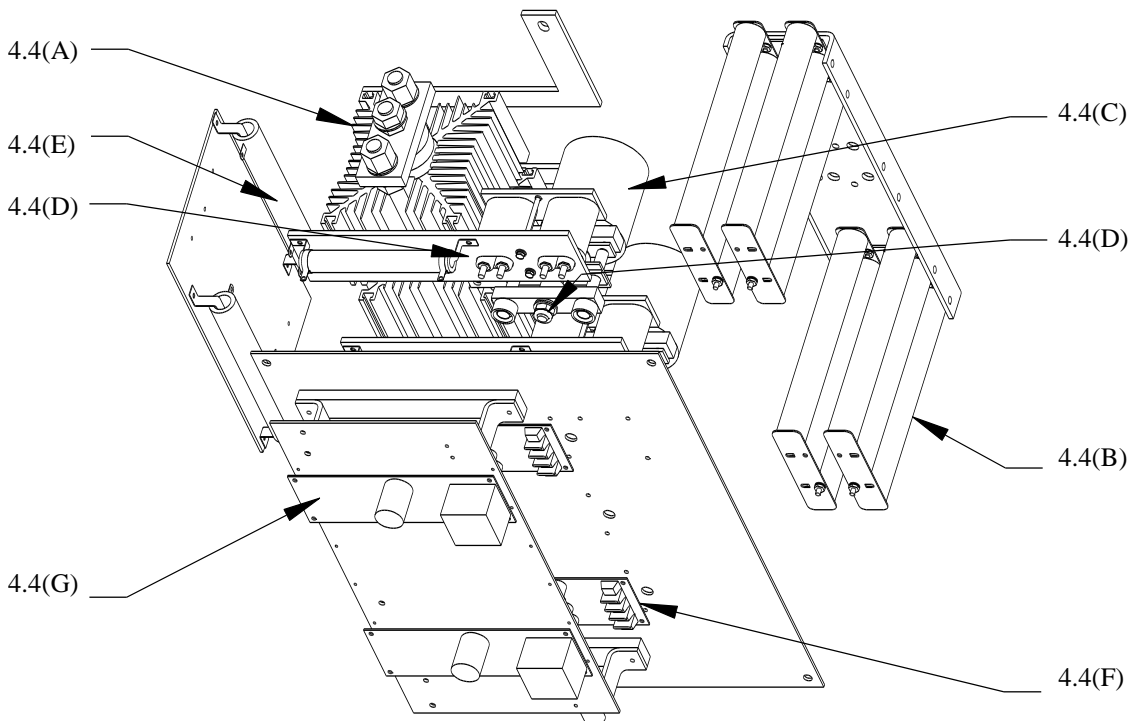


Figure 4.4 – Machine Side Converter Components
(2300 V Machine Side Converter shown)

Three of the machine side converter heatsink assemblies (one in each phase) have thermistors mounted on the heatsinks, each thermistors is wired to a small circuit board (Thermistor Feedback board) which is located near the gate driver boards. In the event of heatsink overtemperature, a fault signal is sent to the controller and the drive will shut down.

Voltage Feedback Circuit Boards

Voltage feedback boards are located in the converter cabinet on the far left side mounted on a vertical glass polyester channel. The boards consist of series connected resistors for sensing input voltage, DC link voltage, and output voltage.

Cooling Fans

There are several different arrangements of cooling fans. Fans are required to remove heat from the drive to ensure proper operation of its components. The fans draw air into the drive through the vented lower doors and exhaust it through vented enclosures at the top of the drive.

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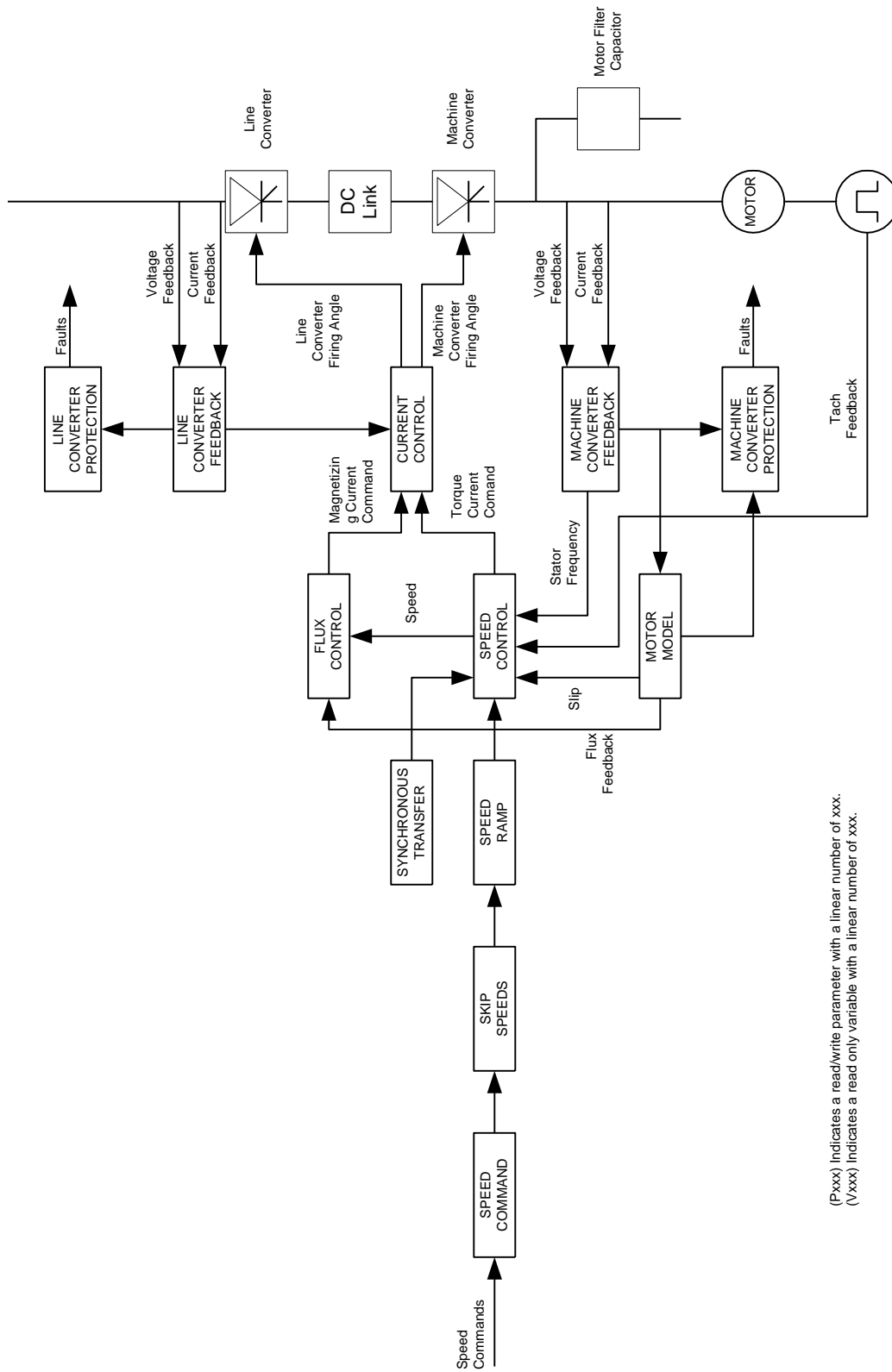
Introduction

The Bulletin 1557 is an adjustable speed ac drive in which motor speed control is achieved through control of the motor torque. The motor speed is measured and the torque is adjusted as required to make the measured speed equal to the speed command. The stator frequency is determined by the motor and load and the drive synchronizes itself to the motor. This is in contrast to the more common volts/hertz ac drive in which the drive determines the stator frequency and does not attempt to synchronize its output to the motor.

The method of control used is known as direct vector control. The term vector control indicates that the position of the stator current vector is controlled relative to the motor flux vector. Direct vector control means that the motor flux is measured, in contrast to the more common indirect vector control in which the motor flux is predicted. In both cases, the stator current is resolved into flux producing and torque producing components which are controlled independently. The intent is to achieve performance similar to a dc machine, in which the torque can be changed quickly without affecting the flux. The flux cannot be changed quickly because of the rotor time constant, which is in the range of seconds for large machines.

The following description of operation is organized in the same functional blocks as the control block diagram (Figure 5.1). Most of the functions are the same as those found in any adjustable speed ac or dc drive. The features which are unique to a direct vector controlled drive are confined to the motor model and flux control functions.

The Bulletin 1557 drive can be used with either induction (asynchronous) or synchronous motors. Synchronous motor drives are identical to induction motor drives except for the addition of a current regulated field supply to the synchronous drive. The features that are unique to a synchronous drive are confined to the flux control function and the encoder option.



(Pxxx) Indicates a read/write parameter with a linear number of xxx.
 (Vxxx) Indicates a read only variable with a linear number of xxx.

Figure 5.1

Speed Command

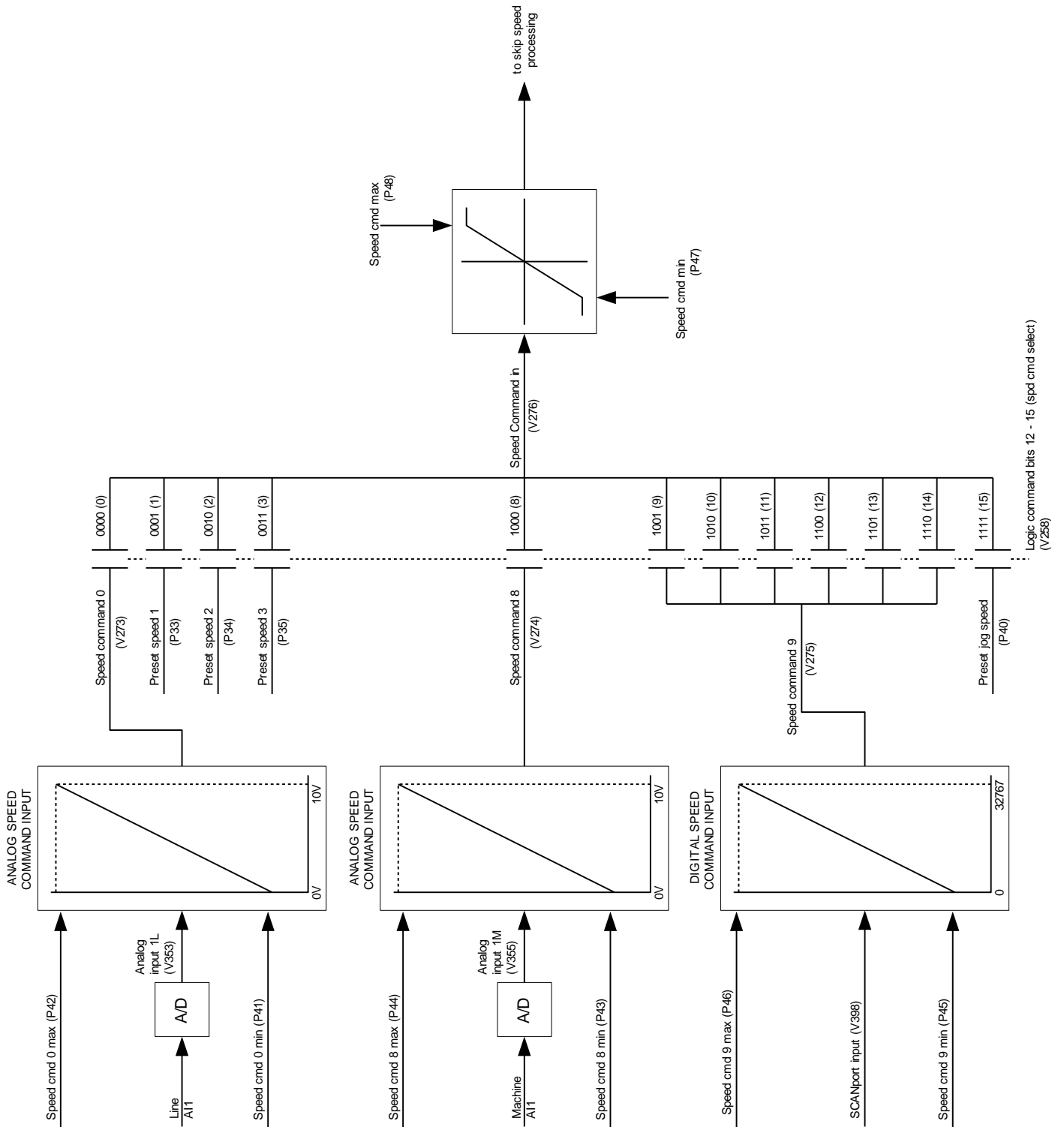
The function of the speed command block is to select one of 12 possible speed command inputs to serve as the drive speed command. Bits 12-15 of the Logic Command are used to select the Speed Command Input from the following list:

- 2 analog inputs (0-10V)
- 3 preset speed commands
- 6 SCANbus ports
- 1 preset jog speed command

The two analog speed command inputs accept 0-10V signals. The range of each of the analog inputs is defined by two parameters. These parameters can be adjusted to cause the speed command to either increase or decrease with an increasing analog input.

The six SCANport ports are multiplexed into a single SCANport input. The range of the digital input is defined by two parameters in the same way as the analog inputs.

The selected speed command input is clamped to a minimum level set by parameter Speed Command Minimum and a maximum level set by parameter Speed Command Maximum. (See Parameter and Variable Description in Chapter 6.)

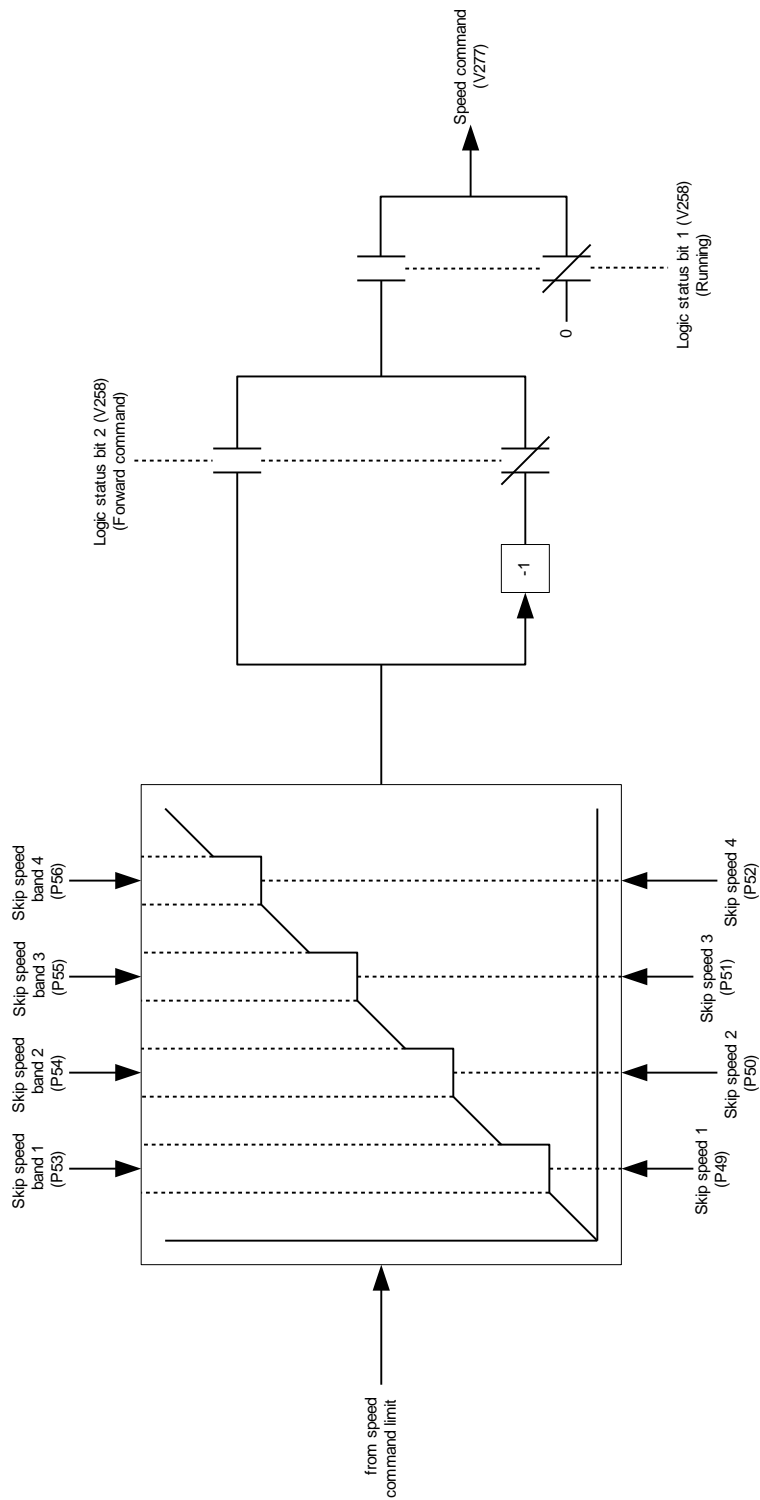


Speed Command

Skip Speeds

Four skip speeds are provided which may be used to prevent the drive from continuously operating at certain speeds, usually to avoid exciting mechanical resonance. Each of the four skip speed zones is defined by two parameters that specify its center point and width. Skip speed zones that overlap are merged.

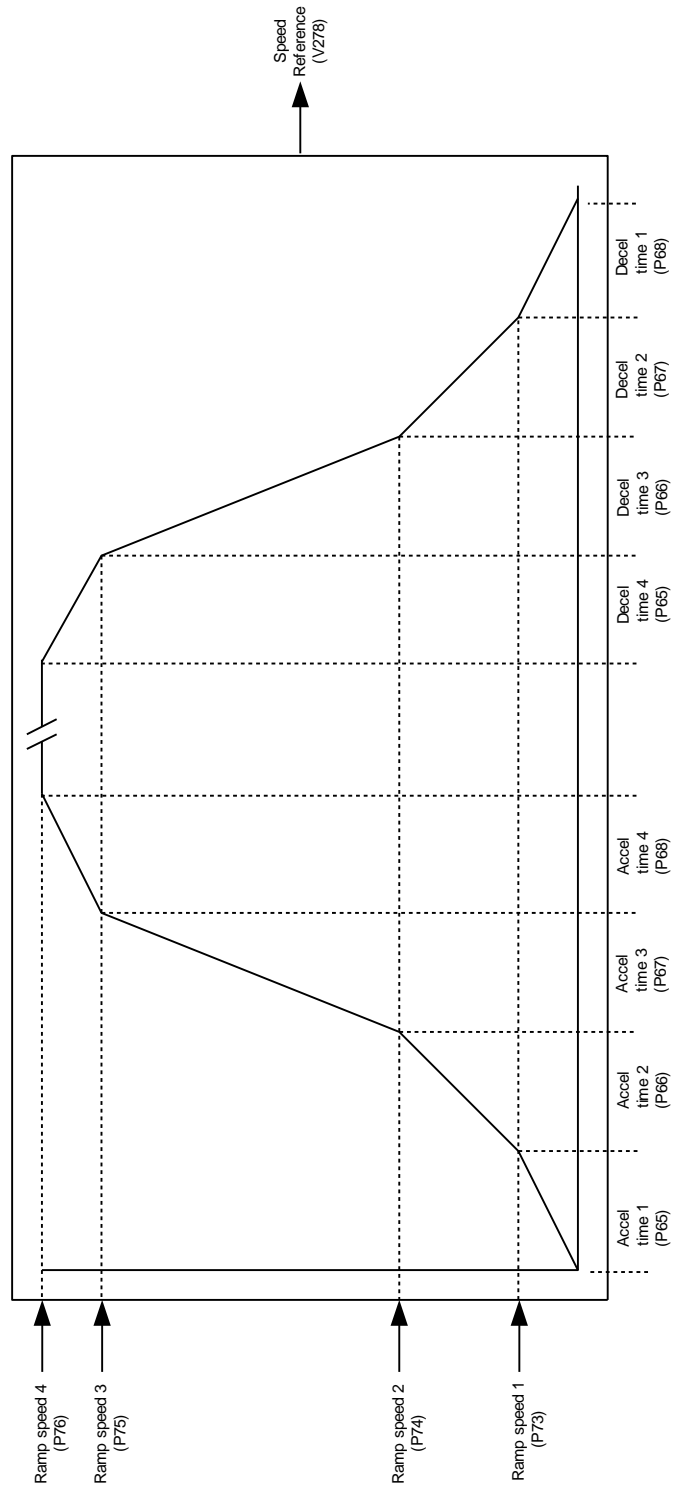
After skip speed processing, the speed command input has its sign changed if reverse rotation is selected, or is set to zero if there is no run request.



Skip Speeds

Speed Ramp

The function of the speed ramp is to control the rate of change of the drive speed reference. Independent four section ramps are provided for acceleration and deceleration. Each ramp is defined by four speed points which are specified by parameters Ramp Speed 1 to 4 which are the same for both accelerating and decelerating, and four time intervals which are specified by parameters Acceleration Time 1 to 4 and Deceleration Time 1 to 4. The input to the speed ramp is the speed command from the skip speed block. The drive control selects the appropriate acceleration or deceleration rate based on the present value of the ramp output and whether it is increasing or decreasing. The output of the speed ramp is the speed reference, which is the input to the speed control block. If the motor is coasting and speed feedback is available, the speed reference is set equal to the motor speed.



Speed Ramp

Speed Control

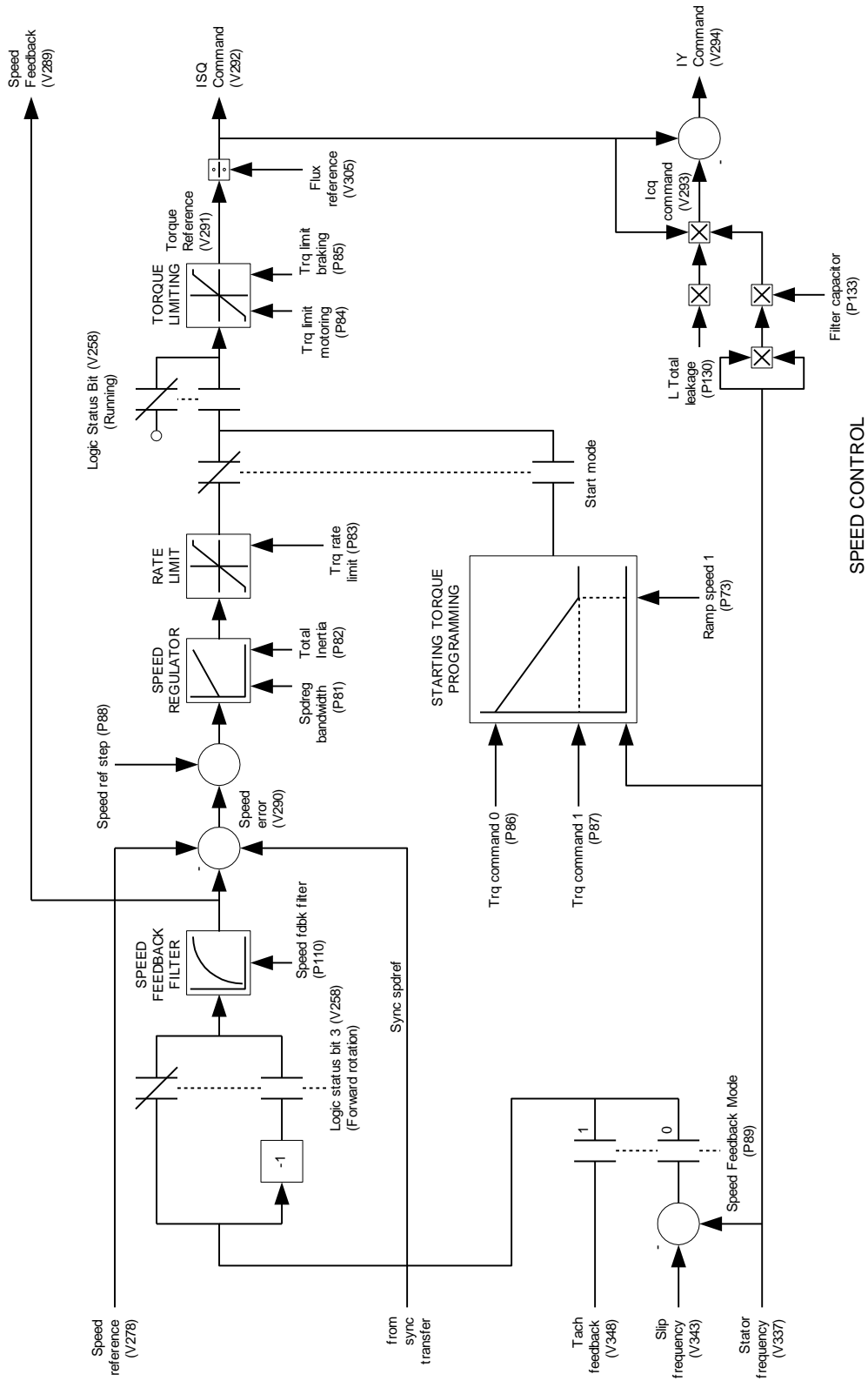
The function of the speed control block is to determine the torque current command. The inputs are the speed reference from the speed ramp, and the stator frequency and slip frequency from the motor model.

Either tach feedback is used, or the slip frequency is subtracted from the stator frequency to determine the motor speed, which is then made negative if the motor is rotating in reverse. The result is filtered by an adjustable second order low pass filter to obtain the drive speed feedback.

The speed feedback is subtracted from the speed reference to determine the speed error. Parameter Speed Reference Step, which is used to demonstrate the step response of the speed loop, is added to the speed error to form the input to the speed regulator. The response of the speed regulator is determined by parameters Speed Regulator Bandwidth and Total Inertia. The rate of change of the speed regulator output is limited to the value specified by parameter Torque Rate Limit. The output of the speed regulator is clamped to the value specified by parameter Torque Limit Motoring for positive values and to the value specified by parameter Torque Limit Braking for negative values. The clamped output of the speed regulator is the torque reference. This is divided by the flux reference to determine I_{sq} Command, which is the torque component of the stator current command.

Without a tachometer, reliable speed feedback is not available at stator frequencies below about 5 Hz. The speed regulator is therefore disabled at low speed and the torque reference is determined by open loop programming. The torque reference changes linearly from the value specified by parameter Torque Command 0 at zero speed to the value specified by parameter Torque Command 1 at Ramp Speed 1, and remains constant above this speed if the drive is still in start mode. When tach feedback is enabled the open loop torque programming is not used.

An estimate of the torque producing current supplied by the motor filter capacitor is calculated from I_{sq} Command, stator frequency, and parameters Total Leakage Inductance and Filter Capacitor. The resulting value is called I_{cq} Command and is subtracted from I_{sq} Command to determine I_y Command, which is the torque component of the dc link current command.



Speed Control

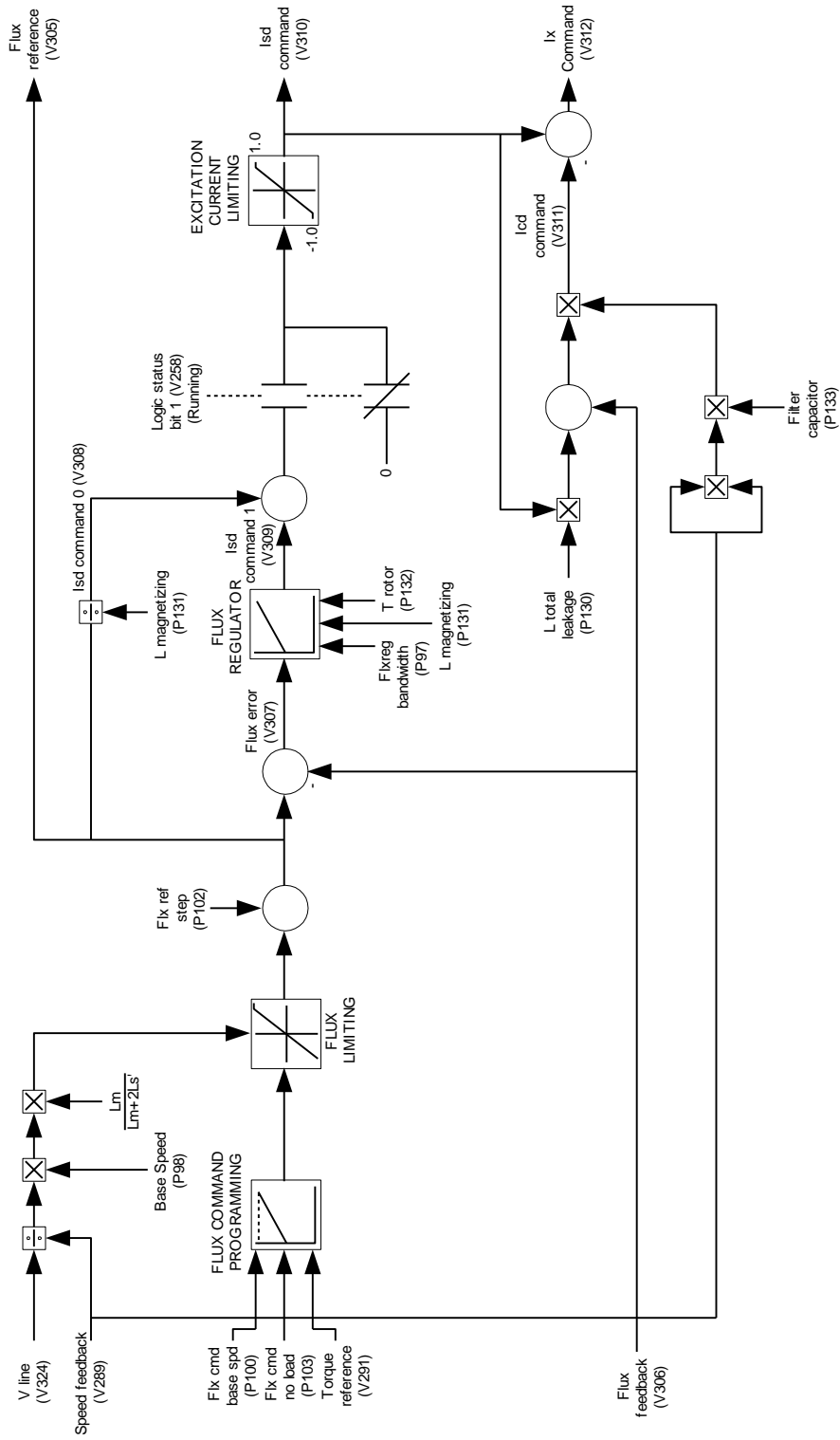
Flux Control

The function of the flux control block is to determine the magnetizing current command. The inputs are flux feedback and stator frequency from the motor model, speed feedback from the speed control block, and line voltage from the current control block.

Below base speed, the flux command varies linearly with Torque Reference from the value specified by parameter Flux Command No Load at zero torque to the value specified by parameter Flux Command Base Speed at rated torque. Above base speed, the drive goes into field weakening and the flux command decreases with increasing speed. The flux command also decreases when the current regulator approaches advance limit or retard limit.

The flux reference is determined by adding parameter Flux Reference Step, which is used to demonstrate the step response of the flux regulator, to the flux command. The flux feedback is subtracted from the flux reference to determine the flux error, which is the input to the flux regulator. The response of the flux regulator is determined by parameters Flux Regulator Bandwidth, Magnetizing Inductance, and Rotor Time Constant. The output of the flux regulator is called Isd Command 1. An open loop estimate of the magnetizing current called Isd Command 0 is determined by dividing the flux reference by parameter Magnetizing Inductance. Isd Command 0 and Isd Command 1 are added to produce Isd Command, which is the magnetizing component of the stator current command.

An estimate of the magnetizing current supplied by the motor filter capacitor is calculated from Isd Command, stator frequency, and parameters Total Leakage Inductance and Filter Capacitor. The resulting value is called Icd Command and is subtracted from Isd Command to determine Ix Command, which is the magnetizing component of the dc link current command. Ix Command becomes negative at high speed because the motor filter capacitor supplies more magnetizing current than the motor requires.



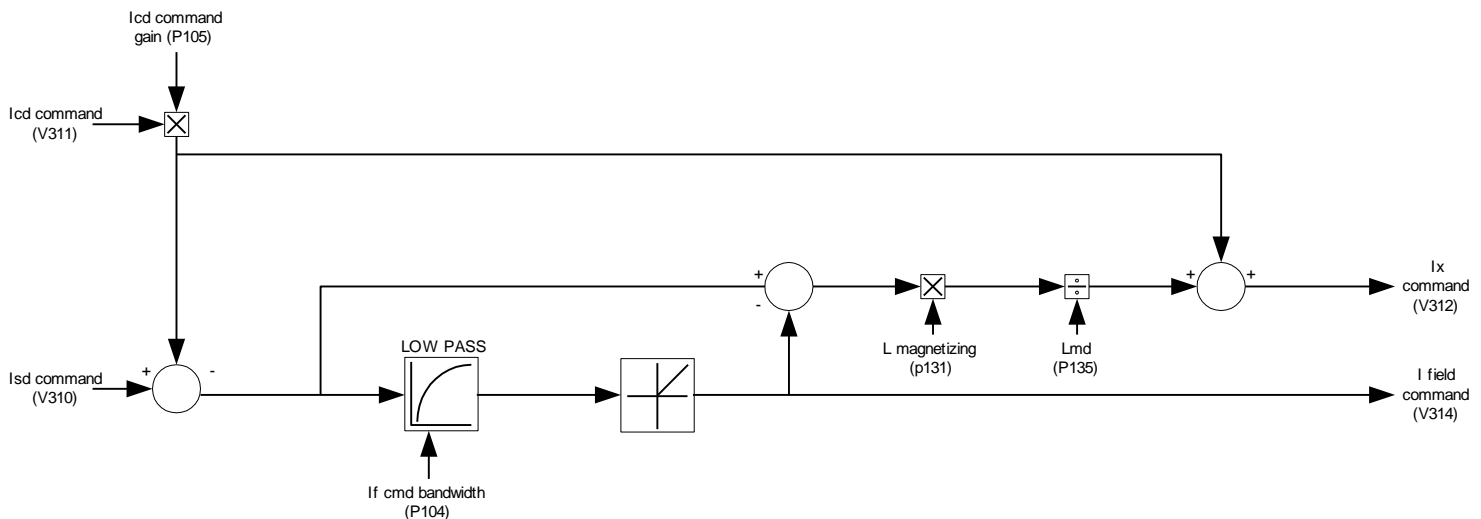
Flux Control

Flux Control for Synchronous Motor

Most of the magnetization for a synchronous motor is supplied by the rotor field winding, unlike an induction motor where all of the magnetizing current is supplied through the stator. However, control of the motor flux through the field current is very slow because of the large time constant of the dc field winding and the current and voltage limitations of the field supply. To obtain sufficiently fast response from the flux regulator the magnetizing current is split into transient and steady state components, with the steady state component supplied through the rotor and the transient component through the stator.

The additions to the flux control required for synchronous machines are shown in the block diagram below. A low pass filter controlled by parameter If Cmd Bandwidth is used to extract the steady state component of Isd Command which becomes I Field Command, the current reference for the field supply. The transient component of Isd Command is obtained by subtracting I Field Command from the original Isd Command and multiplying by the ratio of L magnetizing to Lmd to provide the same gain for the steady state and transient components. The portion of the motor filter capacitor current supplied by the drive is then added to determine Ix Command, which is the magnetizing component of the dc link current command.

Parameter Icd Command Gain determines how the motor filter capacitor current is split between the motor and the drive. When this parameter is set to its minimum value of 0.0, all the capacitor current is supplied by the drive. The line current is higher than the motor current and the motor operates at approximately unity power factor. When this parameter is set to its maximum value of 1.0, all the capacitor current is supplied by the motor. The line current is less than the motor current and the motor operates at a lagging power factor with reduced field current. Increasing Icd Command Gain improves the input power factor of the drive, but also increases the coupling between flux and torque and causes the stability of the flux control to deteriorate.



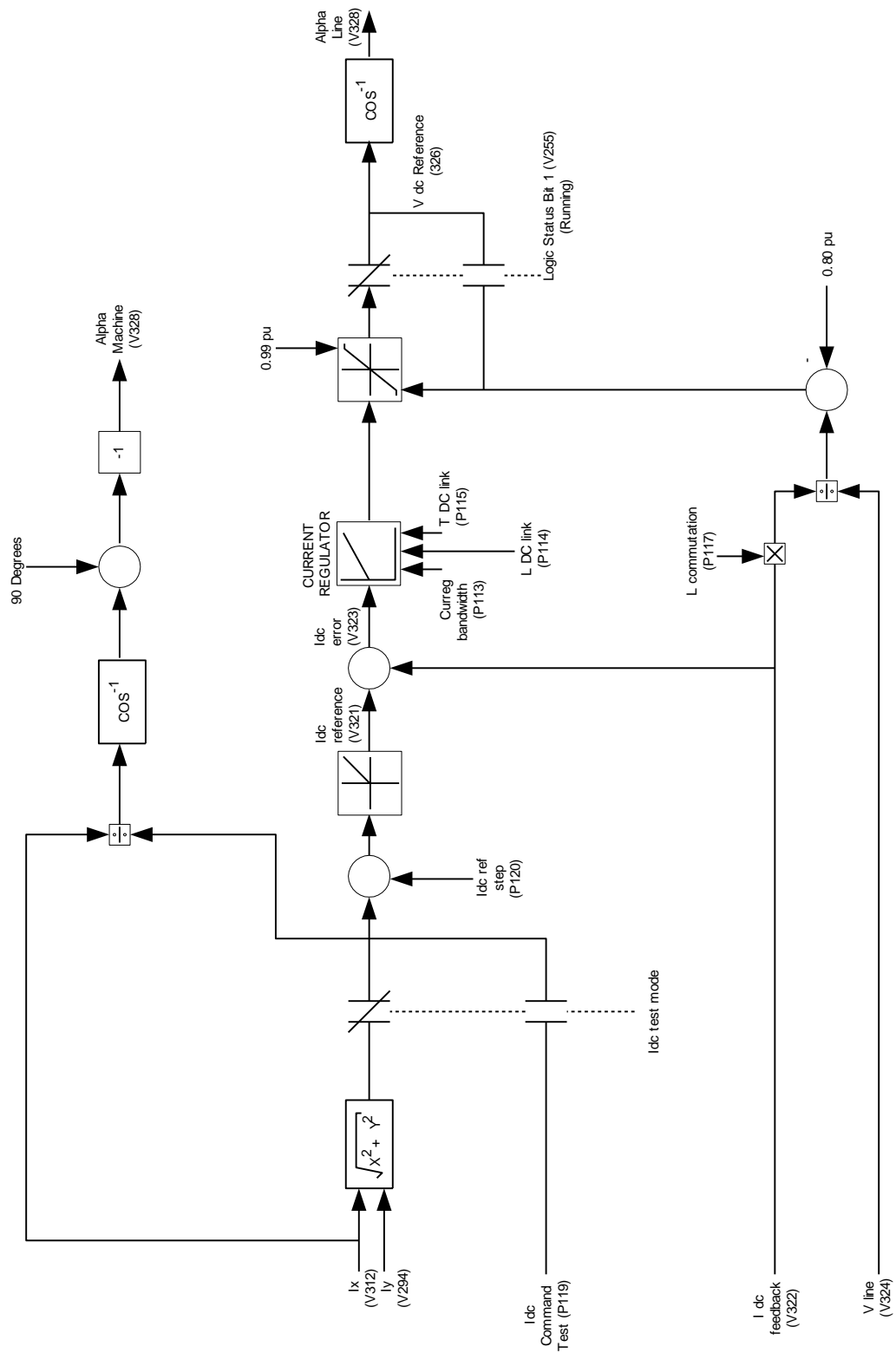
Flux Control for Synchronous Motor

Current Control

The function of the current control block is to determine the firing angles of the line and machine converters. The inputs are the torque and flux producing components of the dc link current command from the speed control and flux control blocks respectively, and the dc link current and line voltage from the line converter feedback.

The square root of the sum of the squares of I_x Command and I_y Command is calculated to determine the dc link current command. In dc current test mode, parameter DC Current Test Command is used as the dc link current command. Parameter DC Current Reference Step, which is used to demonstrate the step response of the current regulator, is added to the current command and the sum is clamped to a minimum value of zero to produce the dc current reference. The dc current feedback is subtracted from the dc current reference to determine the dc current error, which is the input to the current regulator. The response of the current regulator is determined by parameters Current Regulator Bandwidth, DC Link Inductance, and DC Link Time Constant. The output of the current regulator is clamped to a fixed positive limit of 0.990 pu, and to a variable negative limit called the retard limit. Retard limit is calculated from dc current feedback, line voltage feedback, and parameter Commutation Inductance, and its function is to ensure reliable commutation of the line converter when regenerating. When the drive is not running, the dc voltage reference is set equal to the retard limit to force the dc link current to zero as quickly as possible.

The line converter firing angle is the inverse cosine of the dc voltage reference. The machine converter firing angle is determined by taking the inverse cosine of the ratio of I_x Command to the dc current command, adding 90 degrees and changing the sign.



Current Control

Line Converter Feedback

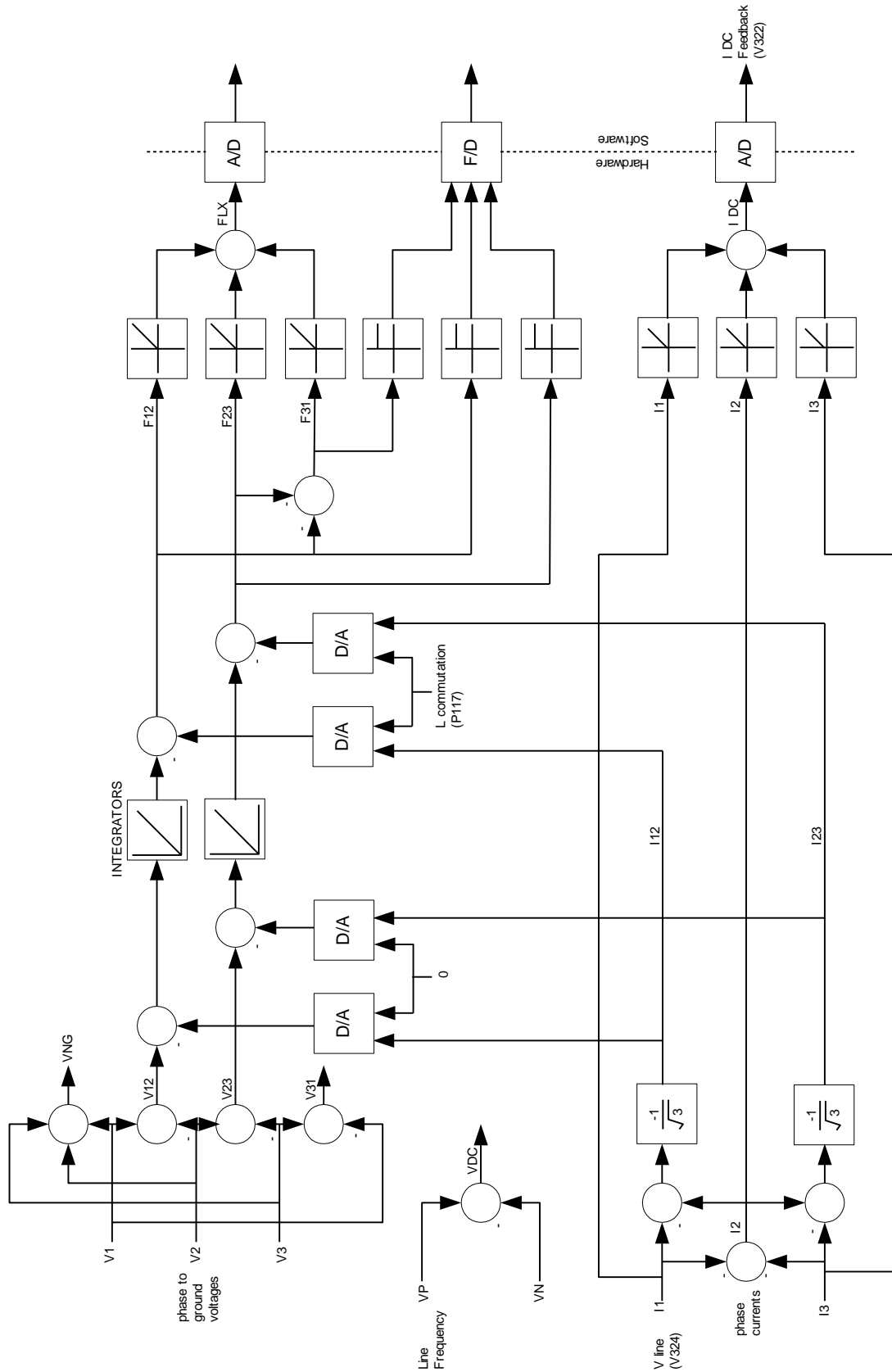
The function of the line converter feedback block is to convert the raw voltage and current feedback signals to the form required by the drive control software. It represents most of the analog portion of the line side Drive Control Board. Since identical hardware is used for both converters, some functions are not used on one or the other.

The two line converter voltage feedback boards provide a total of five voltage feedback signals representing the three ac (V1, V2, V3) and two dc (VP, VN) line to ground voltages. The two dc voltages are subtracted to determine the line side dc link voltage (VDC), which is used by the hardware dc link overvoltage protection. The three ac voltages are summed to produce the neutral to ground voltage (VNG) on the input transformer. This signal is not monitored by the drive control. The three ac line to ground voltages are subtracted from each other to produce the three ac line to line voltages (V12, V23, V31).

The first two line to line voltages are integrated and a signal which is the product of the corresponding (fictitious) "delta" current and the commutating inductance is subtracted from each to compensate for the commutation notches. The resulting reconstructed line voltages are called "flux" signals because the corresponding signals on the machine side represent rotor flux. The third flux signal (F31) is produced by inverting and adding the other two flux signals (F12, F23). The three flux signals are half-wave rectified and added to produce the flux magnitude feedback (FLX), which is proportional to the volts/Hz of the supply and is used as the input to an A/D converter which measures the line voltage magnitude. The flux signals are also converted to three square waves that are combined and used to synchronize the line converter firing to the line voltage.

Current feedback is provided by current transformers in two of the ac input lines. The current in the remaining phase (I2) is reproduced by inverting and adding the other two current feedback signals (I1, I3). The line current feedback signals are subtracted and rescaled to create the two fictitious delta currents (I12, I23) used in the reconstruction of the input voltages described in the preceding paragraph. The three line current feedback signals are also half-wave rectified and added to produce the dc link current feedback (IDC), which is used as the input to an A/D converter and to the hardware overcurrent protection.

The preceding description applies to 6-pulse and 12-pulse converters using the original Drive Control Board 80165-018, which has no voltage feedback from the slave bridge. For 12- or 18-pulse converters using the new 18-Pulse Drive Control Board 80190-118, there is voltage and current feedback from all bridges, which is combined to create an equivalent 6-pulse feedback.



Line Converter Feedback

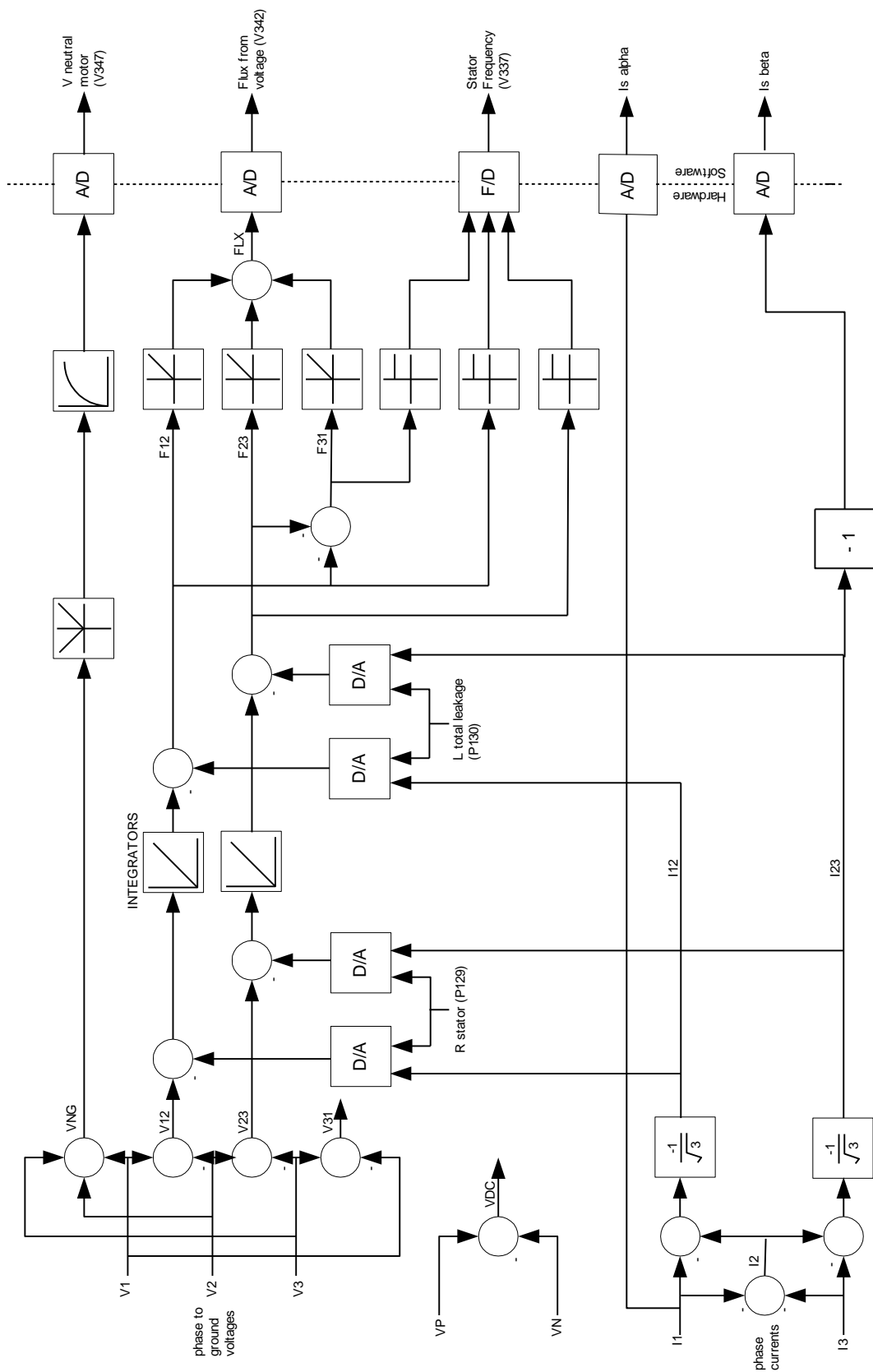
Machine Converter Feedback

The function of the machine converter feedback block is to convert the raw voltage and current feedback signals to the form required by the drive control software. It represents most of the analog portion of the machine side Drive Control Board. Since identical hardware is used for both converters, some functions are not used on one or the other.

The two machine converter voltage feedback boards provide a total of five voltage feedback signals representing the three ac (V1, V2, V3) and two dc (VP, VN) line to ground voltages. The two dc voltages are subtracted to determine the machine side dc link voltage (VDC), which is used by the hardware dc link overvoltage protection. The three ac voltages are summed to determine the motor neutral to ground voltage (VNG), which is used as the input to an A/D converter which measures this voltage for ground fault protection purposes. The three ac line to ground voltages are subtracted from each other to produce the three motor line to line voltages (V12, V23, V31).

A signal that is the product of the corresponding (fictitious) "delta" current and the stator resistance is subtracted from the first two stator voltages to compensate for the stator resistance drop. These two voltages are then integrated and a signal which is the product of the corresponding "delta" current and the motor total leakage inductance is subtracted from each to produce the rotor flux signals. The third flux signal (F31) is produced by inverting and adding the other two flux signals (F12, F23). The three flux signals are half-wave rectified and added to produce the flux magnitude feedback (FLX), which is used as the input to an A/D converter which measures the rotor flux magnitude. The flux signals are also converted to three square waves that are combined and used to determine the stator frequency and to synchronize the machine converter firing to the motor flux.

Stator current feedback is provided by current transducers (LEM's) in two of the motor phases. The current in the remaining phase (I2) is reproduced by inverting and adding the other two current feedback signals (I1, I3). The stator current feedback signals are subtracted and rescaled to create the two fictitious delta currents (I12, I23) used in the reconstruction of the rotor flux described in the preceding paragraph. A three phase to two phase conversion of the stator current feedback is performed by designating phase 1 as the "alpha" phase, and inverting one of the delta current signals to provide the "beta" phase which is in quadrature with the "alpha" phase. These two signals are used as the inputs to A/D converters that measure the two components of stator current.



Machine Converter Feedback

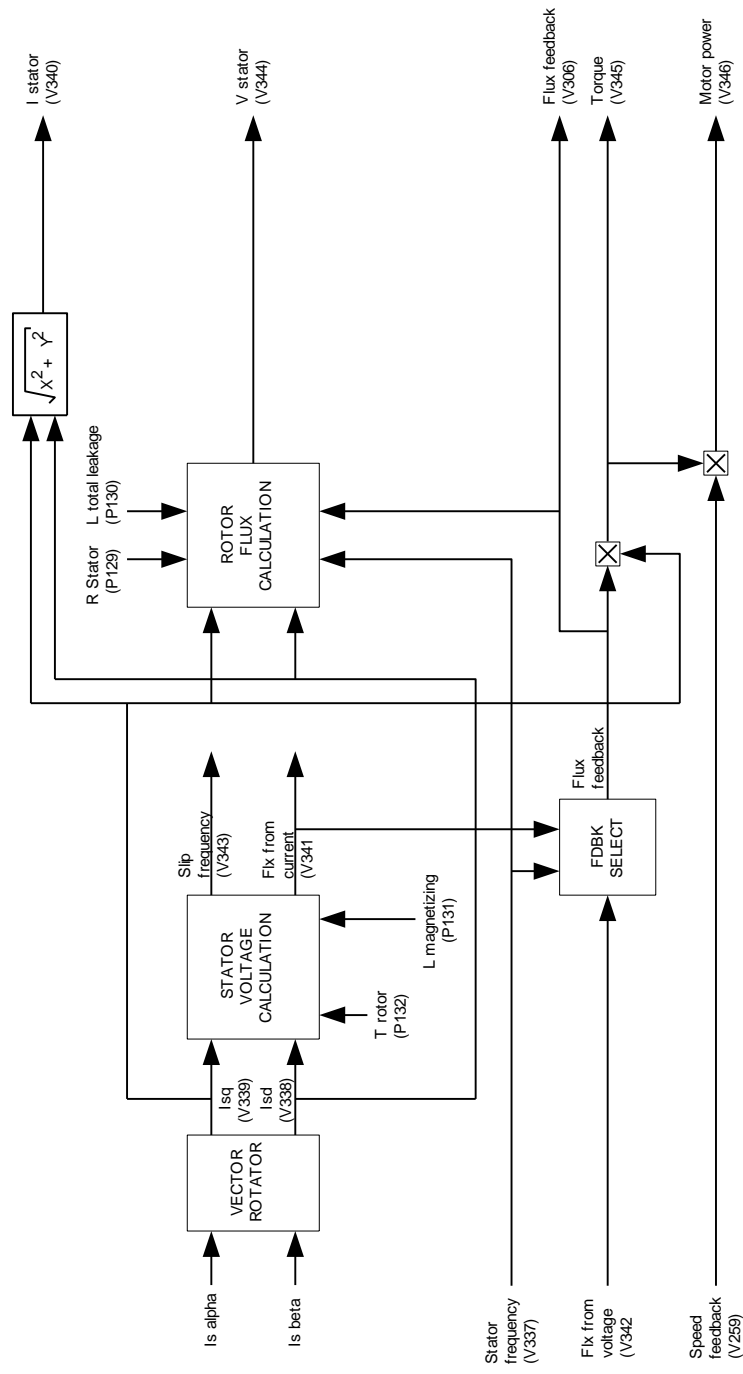
Motor Model

The function of the motor model block is to calculate the motor current, voltage, flux, torque, power, and slip frequency.

After the three phase to two phase conversion described in the machine converter feedback section, the resulting stator current feedback signals (alpha and beta) are converted from analog to digital form. They are then transformed from the stationary reference frame to the rotor flux reference frame that rotates at stator frequency. This transformation produces two components of stator current which, ignoring harmonics, are dc quantities in the steady state. The two components of stator current are the direct axis current (I_{sd}) in phase with the rotor flux, and the quadrature axis current (I_{sq}) which is displaced 90 degrees from the rotor flux. The stator current magnitude is calculated by taking the square root of the sum of the squares of the two components of stator current.

The two components of stator current are used along with parameters Rotor Time Constant and Magnetizing Inductance to calculate the slip frequency and the rotor flux. Slip frequency is used in the calculation of the motor speed. The rotor flux calculated from current is used in the low speed range on drives fitted with a tachometer. The rotor flux determined from voltage and current that is described in the machine converter feedback section is used in the high speed range and is not usable at very low speeds. Without a tachometer, the flux feedback selection is permanently set to the flux feedback derived from voltage and the flux feedback derived from current is not used. Therefore, there is no flux feedback available below about 5 Hz and open loop control is employed as described in the speed control and flux control sections.

The flux feedback is used along with the two components of stator current, the stator frequency, and parameters Stator Resistance and Total Leakage Inductance to calculate the stator voltage. The motor torque is calculated by multiplying the flux feedback by the q-axis current, which is then multiplied by the speed to determine the motor power. Motor voltage, torque, and power are therefore all calculated rather than measured quantities.



Motor Model

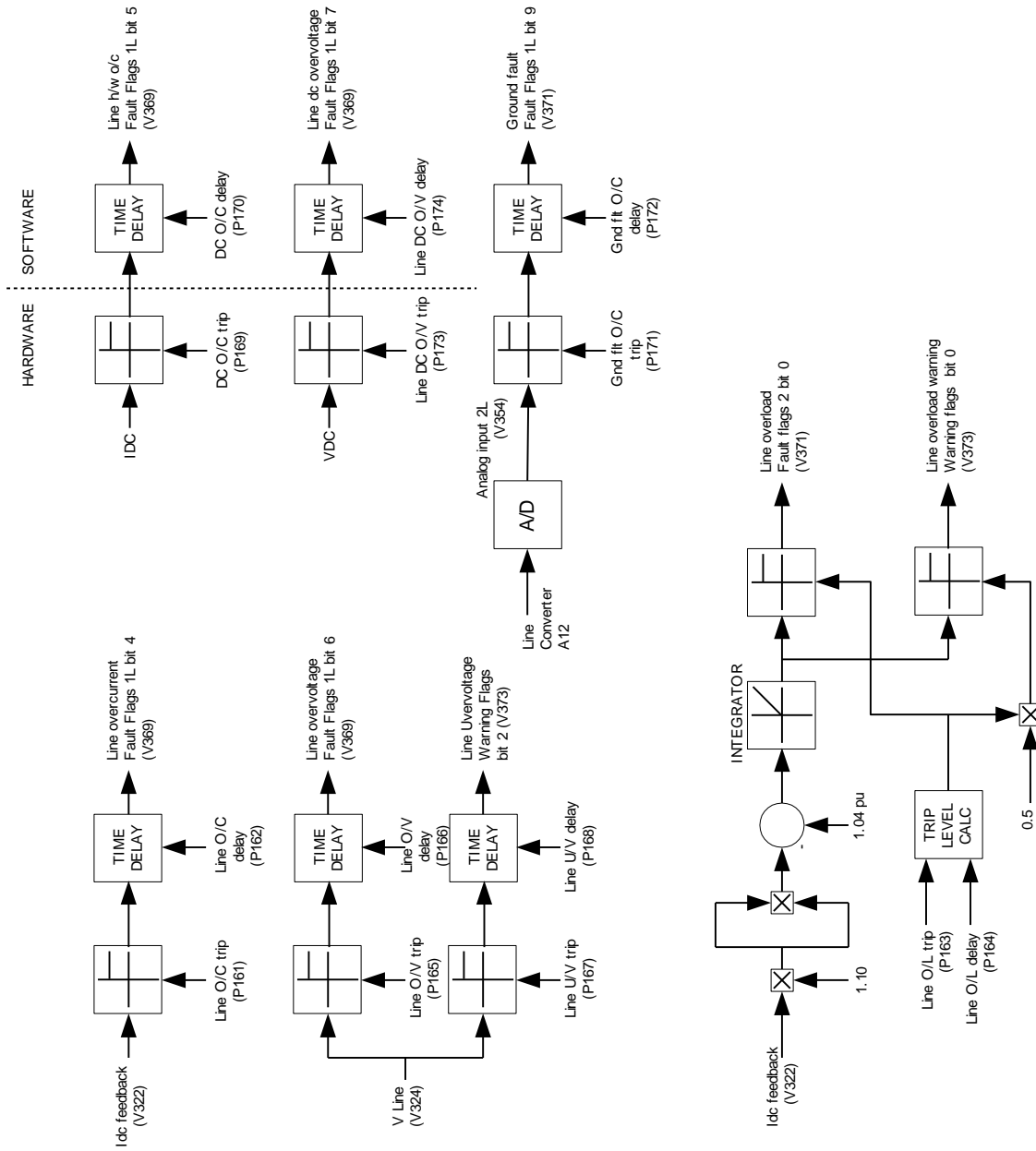
Line Converter Protection

Except for the dc link overcurrent and overvoltage detection, the line converter protection is implemented entirely in software. Adjustable parameters specifying the trip level and time delay are provided for each fault (see Chapter 6, Parameter and Variables Description). The dc link current and line voltage feedback are obtained as described in the section on line converter feedback. The current feedback for ground fault detection is obtained from a zero sequence current transformer installed in the drive input (only on drives with AC line reactor). The voltage across the CT burden resistor is measured through a differential analog input (AI2) on the line converter Drive Control Board.

For all faults except line converter overload, if the measured voltage or current exceeds the specified trip level for the specified time interval, the corresponding fault bit is set in one of the fault words and the master fault bit is set in Logic Status 1. For the detection of overload faults, the dc link current is first converted to its ac equivalent by multiplying by 1.10 and then squared. The amount by which the square of the current exceeds a threshold level is then integrated with time. An overload fault is declared if the output of the integrator exceeds the trip level calculated from the specified overload trip level and time. An overload warning is issued when the $I^2 t$ level reaches half the trip level.

The response to a line converter fault falls into three categories, depending on the type of fault. For class 1 faults, such as line overcurrent, line overvoltage and undervoltage, and dc link overcurrent and overvoltage, the line converter is immediately phased back to retard limit until the current drops to zero. The gating is then disabled and the input and output contactors are opened. For class 2 faults, such as ground fault and overload, the motor is brought to a normal stop before the drive is shut down and the contactors opened. For class 3 faults (warnings), such as a pending overload, no action is taken.

The dc link overcurrent and overvoltage are special cases in that the fault detection is performed by hardware but the time delay is performed by software. The detection of these two faults is implemented in hardware because a very fast response is required. The hardware fault detection responds to instantaneous values rather than average values as the software fault detection does. The response to dc link overcurrent faults is different from all other faults because it freezes the GTO gating until the dc link current has dropped to zero. This action is taken to prevent the GTO's from being destroyed by attempting to commutate a current above their safe rating. Line converter current feedback is used for this function instead of motor current feedback because the motor current includes the current supplied by the filter capacitor, which does not flow through the GTO bridge.



Line Converter Protection

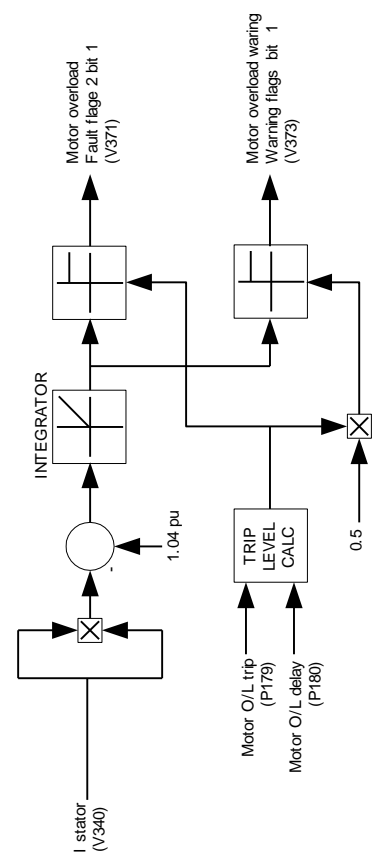
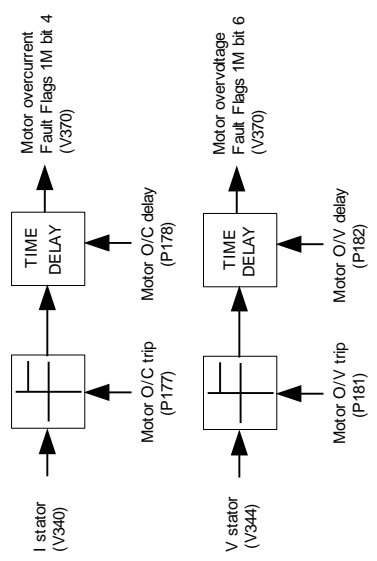
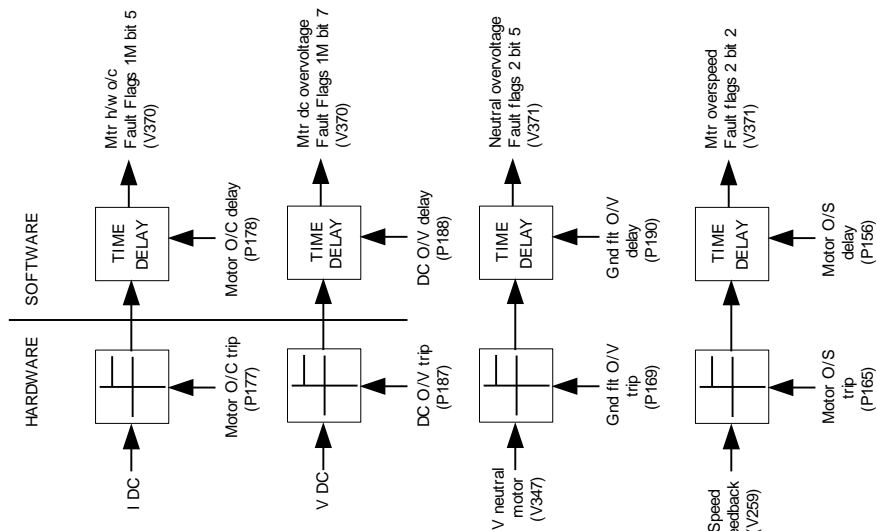
Machine Converter Protection

Except for the hardware overcurrent and dc link overvoltage detection, the machine converter protection is implemented entirely in software. Adjustable parameters specifying the trip level and time delay are provided for each fault. The motor current and voltage feedback are obtained as described in the motor model section. The motor speed feedback is derived by measuring the stator frequency and adding the calculated slip frequency as described in the section on speed control.

For all faults except motor overload, if the measured voltage, current, or speed exceeds the specified trip level for the specified time interval, the corresponding fault bit is set in one of the fault words and the master fault bit is set in Logic Status. For the detection of overload faults, the amount by which the square of the motor current exceeds a threshold level is integrated with time. An overload fault is declared if the output of the integrator exceeds the trip level calculated from the specified overload trip level and time. An overload warning is issued when the $I^2 t$ level reaches half the trip level.

The response to a machine converter fault is exactly the same as the response to a line converter fault.

The hardware overcurrent and dc link overvoltage are special cases in that the fault detection is performed by hardware but the time delay is performed by software. The detection of the dc link overvoltage is implemented in hardware because a very fast response is required. The hardware fault detection responds to instantaneous values rather than average values as the software fault detection does. The hardware motor overcurrent detection is provided because it is required for dc link overcurrent detection on the line converter, and both converters use identical Drive Control Boards.



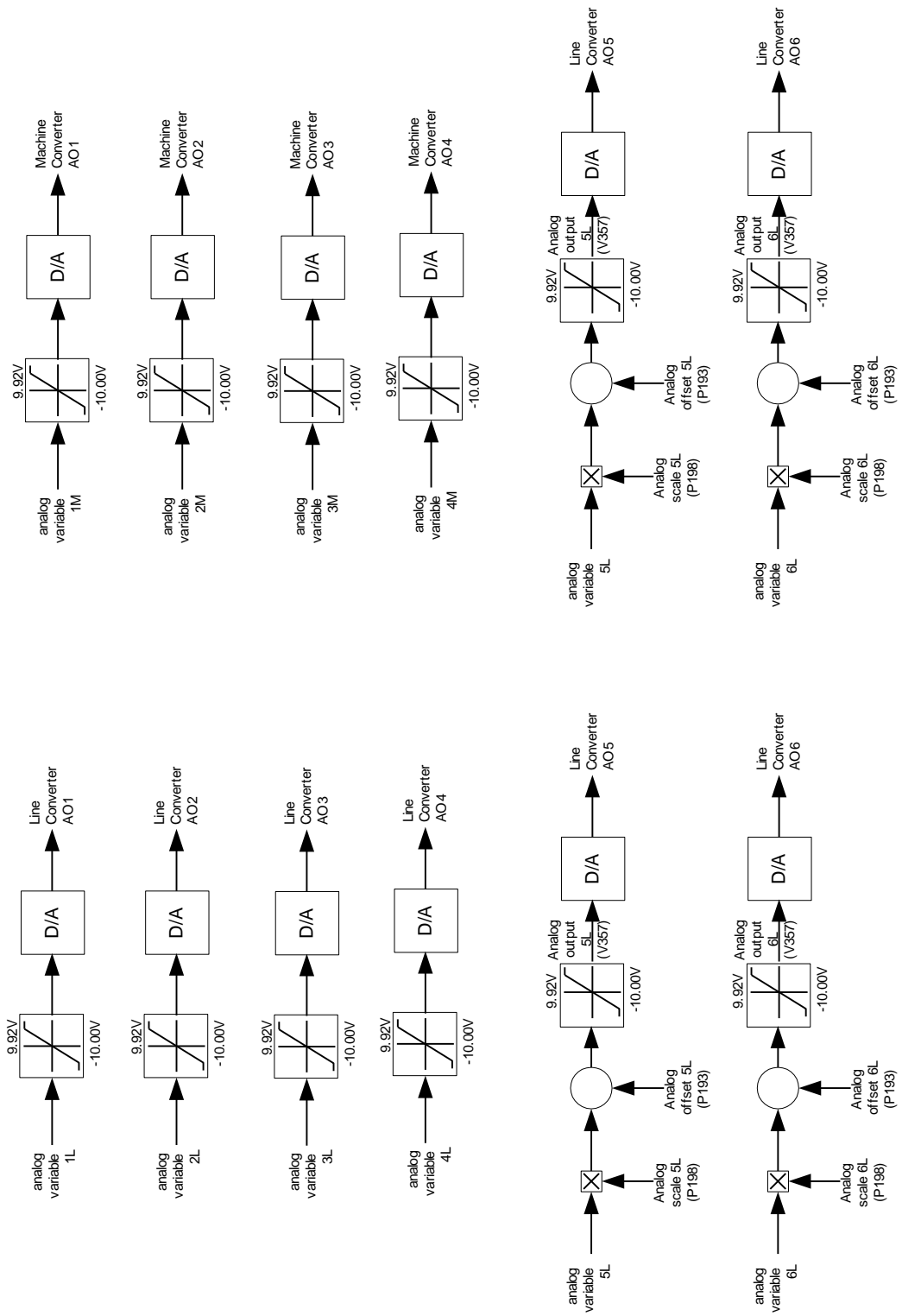
Machine Converter Protection

Analog Outputs

A total of twelve programmable analog outputs is provided, six on each of the two Drive Control boards. The analog outputs are 8-bit, non-isolated, with a range of -10V to +10V. The arrangement of analog outputs is different for the original Drive Control boards 80165-018 and the new 18-Pulse Drive Control boards 80190-118. For the original boards, four of the six analog outputs on each board are intended for diagnostic purposes and are available at test points for connection to an oscilloscope or chart recorder. The remaining two analog outputs on each board are intended for connection to external devices such as meters or isolation modules, and are available at the analog I/O connector on each board. With the new 18-pulse boards, the analog outputs are split equally between three diagnostic outputs and three external outputs. The allocation of the analog outputs is shown below:

<u>No.</u>	<u>Output</u>	<u>Control Board</u>	<u>80165-018</u>	<u>80190-118</u>
1	Analog output 1L	Line (lower)	Test point AO1	Test point AO1
2	Analog output 2L	Line (lower)	Test point AO2	Test point AO2
3	Analog output 3L	Line (lower)	Test point AO3	Test point AO3
4	Analog output 4L	Line (lower)	Test point AO4	Connector J8
5	Analog output 1M	Machine (upper)	Test point AO1	Test point AO1
6	Analog output 2M	Machine (upper)	Test point AO2	Test point AO2
7	Analog output 3M	Machine (upper)	Test point AO3	Test point AO3
8	Analog output 4M	Machine (upper)	Test point AO4	Connector J8
9	Analog output 5L	Line (lower)	Connector J5	Connector J8
10	Analog output 6L	Line (lower)	Connector J5	Connector J8
11	Analog output 5M	Machine (upper)	Connector J5	Connector J8
12	Analog output 6M	Machine (upper)	Connector J5	Connector J8

Any parameter or variable can be assigned to any analog output, but it should be kept in mind that the analog outputs on the two Drive Control Boards are serviced at different rates. The analog outputs on each board are updated six times per cycle, which means that the line converter outputs are updated at a fixed rate while the update rate for the machine converter varies with motor speed. The scaling of the variables assigned to the analog outputs is given in the variable descriptions and cannot be changed. However, the four or six external outputs are each provided with an adjustable offset and scale factor which are applied after the predefined scaling to allow these outputs to be rescaled to suit the external device they are driving.



Analog Outputs

Test Modes

The Bulletin 1557 drive is provided with five test modes that are selected by parameter Test Mode in the Feature Select group. When Test Mode is set to the default value of zero, the drive is in the normal operating mode. If the value of this parameter is changed when the drive is running, the change will not take affect until the drive is stopped.

Setting Test Mode to 1 selects the gate test mode. This mode is used to check the thyristor gating with the medium voltage off. The line converter gating is at the rated line frequency but is not synchronized with the line voltage and has positive phase rotation only. The machine converter gating is the same as in normal operation. The output frequency is determined by the speed reference. Both the input and output contactors must be open and medium voltage must not be applied to the drive.



CAUTION: Application of medium voltage to the drive input or output when it is operating in gate test mode may cause severe damage to the drive.

Setting Test Mode to 2 selects the dc current test mode. This mode is used to test the line converter and to tune the current regulator and the line commutating impedance. In the dc current test mode, the line converter operates normally but the machine converter gating is modified to gate both the positive and negative legs in the same phase in order to short-circuit the dc link current through the machine converter. The short circuit current is slowly rotated among the three phases with overlap between phases to ensure that an open circuit does not occur during commutation. There is no current in the motor and the output contactor must be open. The dc current command is set equal to the value specified by parameter DC Current Test Command in the Current Control Parameters group.

Setting Test Mode to 3 selects the system test mode. This mode is used to test the drive as a system, including interfaces with external devices such as programmable controllers, without applying power to the drive or motor. The drive behaves as if it was running normally but all thyristor gating is inhibited. Since the input, output, and bypass contactors operate normally in this mode, the drive cannot prevent medium voltage being applied to the drive or motor and other measures must be taken to ensure that this does not occur.



CAUTION: It is the responsibility of the operator to ensure that the drive and motor are isolated from medium voltage when the drive is operating in system test mode with the input, output, and bypass contactors closed.

Setting Test Mode to 4 selects the open circuit test mode. This mode is used to test the drives at rated output voltage and frequency without connecting it to a motor. In open circuit test mode, ac current sufficient to produce rated voltage at the drive output is forced through the output filter capacitors. When the drive is started in this mode, it ramps up to rated frequency and synchronizes its output voltage with the line voltage. The current reference is set to a value that will produce approximately rated voltage at the drive output. The output voltage can be changed by adjusting parameter Flux Command Base Speed.



CAUTION: Open circuit test mode should not be used when the drive is connected to a load unless an output contactor is provided.

Synchronous Transfer

Synchronous transfer is an optional feature of the Bulletin 1557 ac drive which allows a motor to be transferred between the drive and a fixed frequency supply in either direction without stopping and with a very short interruption of power to the motor. Compared to a simple non-synchronous transfer in which power to the motor is interrupted for a significant length of time, the transient drop in motor speed is much less with synchronous transfer.

In order to perform a synchronous or non-synchronous transfer both a drive output contactor and a bypass contactor are required. The name "bypass" indicates that the function of this contactor is to connect the motor directly to the fixed frequency supply, bypassing the drive.

Synchronous transfer also requires the optional second discrete I/O board to produce the three inputs and one output used for this function. The three inputs are the "bypass contactor closed" status input, and the "transfer to bypass" and "transfer to drive" command inputs. The one output is "close bypass contactor".

In most single motor and all multiple motor applications, a programmable controller is used for overall control of the synchronous transfer operation. Because of the risk of damage to the motor and drive if the bypass contactor is closed at the wrong time, close co-ordination is required between the drive and the programmable controller for the successful execution of a synchronous transfer. In particular, when transferring from drive to bypass, the time interval between the drive shutting off and the bypass contactor closing must be accurately controlled. Typically, the PLC gives control of the bypass contactor to the drive before performing the transfer, and takes back control after the transfer is completed.



CAUTION: Since the programmable controller and not the drive controls the output and bypass contactors, the transfer command must always go via the PLC and never directly to the drive from another controlling device (e.g. a Remote I/O adapter).

Since the drive does not have any means of measuring the input voltage of the bypass contactor, the drive input voltage is used as the phase reference for synchronization. Independent verification of the phase rotation and phase angle of the bypass voltage relative to the drive input voltage is therefore absolutely essential.



CAUTION: If the phase rotation and phase angle of the bypass voltage compared to the drive input voltage are not correct, severe damage may occur to the drive, motor, couplings, and driven equipment if a transfer to bypass is attempted.

As a precaution, a synchronous transfer will not be performed if the phase sequence of the line voltage is not positive.

Transfer to Bypass

When the motor is running on the drive and a synchronous transfer to bypass is required, the transfer takes place as described below:

1. Before a transfer to bypass is requested, the drive must be given control of the open bypass contactor. Since the drive is running, it will already have control of the output contactor. The "transfer to bypass", "transfer to drive", and "bypass contactor closed" inputs and the "close bypass contactor" output must all be off at this time.
2. The drive is given a "transfer to bypass" command, which must remain active until the synchronous transfer is complete. If the transfer command is removed before the bypass contactor is requested to close, the drive will abort the transfer and return to normal running. When the drive receives the transfer command, it accelerates the motor up to line frequency. If the drive is unable to achieve synchronous speed, it may be necessary to increase parameter Torque Limit Motoring.
3. When the motor reaches synchronous speed, the synchronizing regulator is activated. The synchronizing regulator adjusts the drive speed reference as required, to synchronize the motor to the line with the motor voltage leading the line voltage by an angle specified by parameter Synchronous Transfer Lead Angle. This parameter can be used to compensate for any phase difference between the bypass voltage and the drive input voltage. The response of the synchronizing regulator is controlled by parameter Synchronizing Regulator Gain. If the phase error tends to oscillate, it may be necessary to adjust parameters Synchronizing Regulator Gain or Speed Regulator Bandwidth.
4. When the phase error between the motor voltage and line voltage has remained less than the value specified by parameter Synchronizing Error Maximum for the time interval specified by parameter Synchronizing Time, the drive activates its "close bypass contactor" output. If the drive is unable to synchronize within the time specified by parameter Sync Transfer Time, the synchronous transfer is aborted.
5. After a time delay specified by parameter Synchronous Transfer Off Delay, the drive shuts off. It is very important that parameter Synchronous Transfer Off Delay is set to the correct value. This should be slightly less than the contactor closing time. If this time delay is set too short the motor voltage could drift out of phase with the bypass voltage during the time the motor is not under power, producing a large current and torque transient when the bypass contactor closes, and possibly causing protective equipment to operate. If the time delay is set too long, a drive overcurrent fault may occur because the drive is unable to control its output voltage and frequency once the bypass contactor has closed.



CAUTION: If parameter Synchronous Transfer Off Delay is set incorrectly, damage may occur to the drive, motor, couplings, and driven load if a transfer to bypass is attempted.

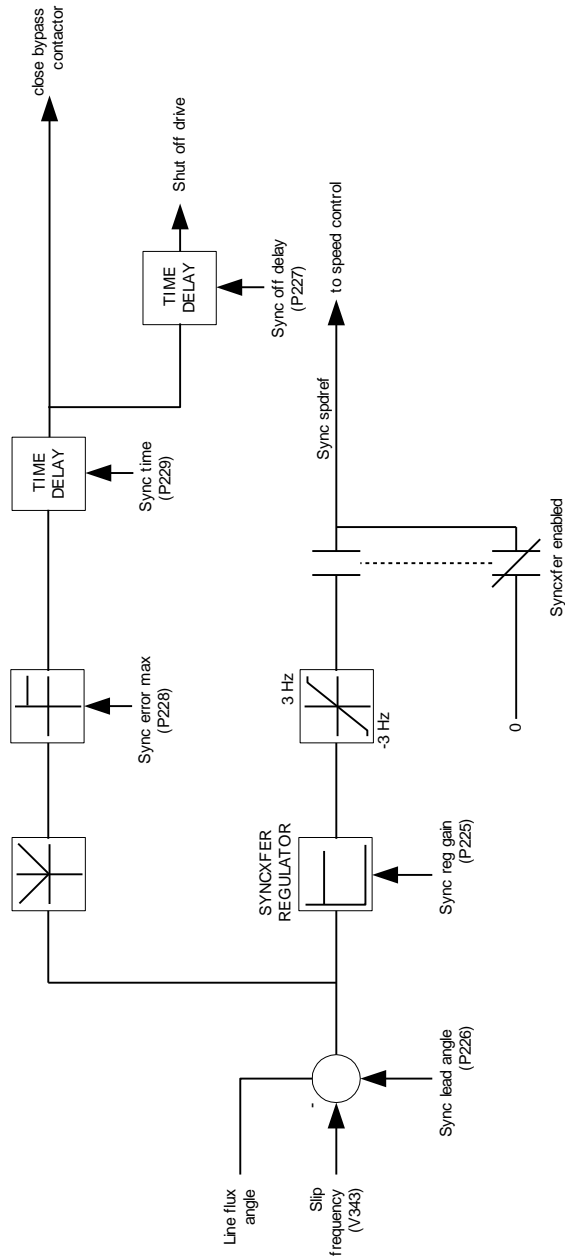
6. When the "bypass contactor closed" input indicates that the bypass contactor has closed, the drive deactivates the "close output contactor" output. When the output contactor opens, the drive is disconnected from the motor, leaving the output filter capacitors charged to line voltage. It may take several minutes for the capacitors to discharge.
7. Control of the closed bypass contactor is taken away from the drive.
8. The "transfer to bypass" command is removed, causing the drive to deactivate its "close bypass contactor" output. The synchronous transfer is now complete and the motor is running on bypass.

Transfer to Drive

The drive must synchronize itself with the motor voltage while the motor is still running on bypass, in order to perform the transfer to drive before the motor flux decays. The output contactor must therefore be closed with the motor still connected to the line in order to pre-charge the output filter capacitors.

When the motor is running on bypass and a transfer to drive is required, the transfer takes place as described below:

1. The drive is given a "transfer to drive" command. Initially, both the "close output contactor" and "close bypass contactor" outputs will be off. When the drive receives the transfer command, it activates its "close bypass contactor" output and runs its output frequency up to rated line frequency. The programmable controller must wait for at least 2 seconds to allow the drive to ramp up to rated frequency.
2. The drive is given control of the closed bypass and open output contactors.
3. The drive is given a normal start command, which causes it to activate its "close output contactor" output.
4. After the "output contactor closed" input indicates that the output contactor has closed, there is a short delay to allow the output filter capacitors to charge. The drive then deactivates its "close bypass contactor" output.
5. When the "bypass contactor closed" input indicates that the bypass contactor has opened, the drive goes to run mode. As the drive brings the motor torque up to the level required by the load, the motor speed will drop slightly before returning to line frequency. A drop in speed is unavoidable because the drive cannot know in advance what torque will be required.
6. The "transfer to drive" command is removed. The synchronous transfer is now complete and the motor is running on the drive. The drive retains control of the output contactor for protection purposes.



Transfer to Drive

Thyristor Diagnostics Bulletin 1557 Drive

The Bulletin 1557 ac drive tests for open or shorted thyristors both when it is started and continuously while running. The method used to detect failed thyristors is different for starting and for running, but the same hardware is used in both situations. The drive control receives a feedback signal via a fibre optic cable from each thyristor gate driver that indicates whether the anode-cathode voltage of the thyristor is high or low. A high voltage across a thyristor indicates that it is almost certainly not conducting. A low voltage across a thyristor indicates that it may be conducting, but since it is quite normal for the voltage across a device to be low even when it is not conducting, this is not a reliable indication that the device is on.

The following description applies to all air cooled and liquid cooled 1557 drives except the small 1557M drive which does not have any feedback from its gate drivers and uses a completely different method to detect failed thyristors.

Detection of Failed Thyristors When Starting**Line Converter**

When line voltage is applied to the drive but it is not running (i.e. gating is off), the voltage across the line converter thyristors is high most of the time but low twice per cycle during an interval around the zero crossings of the line voltage. Shorted thyristors in the line converter can therefore be detected whenever line voltage is applied even when the gating is off. If the feedback from the gate driver indicates that the voltage across a device is continuously low for six cycles, then it is assumed to be shorted. The six cycle interval is required to eliminate spurious faults.

If the feedback from the gate driver indicates that the voltage across a device is continuously high for six cycles, then an open thyristor fault will be annunciated. Since it not possible to tell if a thyristor is actually open without gating it, an open fault at this time indicates that the feedback from the gate driver has failed.

When the drive receives a start command, a gating test of the line converter thyristors is performed. Thyristors are gated one at a time at intervals of one cycle to determine if they conduct. The one cycle delay between devices is required to allow the snubbers to recharge. A short gating pulse is applied near the point in the cycle when the voltage across the device is at its positive peak. If the voltage across the device does not collapse, then it is assumed to be open. This test can also identify errors in the connection of the fibre optic cables. An open thyristor fault at this time indicates that the thyristor or gate driver board is defective, or that the fibre optic cable is plugged into the wrong transmitter or receiver on the Optical Interface board. When two thyristors in the same leg seem to be open, it is usually because their fibre optic cables have been interchanged.

Machine Converter

If no open or shorted thyristors are detected, the line converter is gated at a firing angle of 90 degrees with the machine converter gating off in order to apply a voltage to the dc link. Although a firing angle of 90 degrees corresponds to an average dc voltage of zero when the dc current is continuous, with the machine converter gating off the snubber capacitors will charge up to the peak of the voltage waveform, resulting in a dc link voltage which is close to rated voltage. After a delay to allow the dc voltage to build up to its maximum value, the feedback from the GTO gate drivers is examined. If the gate driver feedback indicates that the voltage across a GTO is still low, then that device is assumed to be shorted. If all devices in one leg of the bridge are shorted, all devices in the other two legs on the same side (positive or negative) of the bridge may incorrectly appear to be shorted because they are connected in parallel with the shorted leg through the low impedance of the motor. For this reason, if the drive is indicating that a number of machine converter thyristors are shorted, all devices should be checked with an ohmmeter to confirm that they actually are shorted before replacing them.

If no shorted devices are detected, a gating test of the machine converter thyristors is performed. Thyristors are gated one at a time at intervals of 20 ms to determine if they conduct. The 20 ms delay between devices is required to allow the snubbers to recharge. Each device is gated for approximately 100 microseconds while the gate driver feedback is monitored. If the voltage across the device does not go low, then it is assumed to be open. An open thyristor fault at this time indicates that the thyristor or gate driver board is defective, or that the fibre optic cable is plugged into the wrong transmitter on the Optical Interface board. When two thyristors in the same leg seem to be open, it is usually because their fibre optic cables have been interchanged. The machine converter gating test is not included in firmware revisions earlier than 4.20.

Detection of Failed Thyristors When Running

Detection of thyristor faults is much simpler when the drive is running than when it is started because no special gating is required. When the gating is enabled for both converters, the feedback from the gate drivers is constantly switching on and off, usually several times per cycle. The gate driver feedback signals from each device are sampled a number of times during each cycle. If any of the conduction feedback signals indicates that the voltage across a thyristor is continuously high or low for six cycles then the corresponding device is assumed to be open or shorted respectively. The detection interval of six cycles, which is required to eliminate spurious faults, makes the fault detection too slow to protect thyristors from failing, but it does shut the drive off after a device has failed in order to prevent additional failures from occurring.

Drives that have an extra redundant thyristor in each leg of the bridge will issue a warning and continue running if a single device in a leg fails short, but will trip if a second device fails in the same leg.

When the drive is running, an open thyristor is treated as a warning, not a fault, because it is not possible for a device to fail open when high voltage is applied and gating is on. An open thyristor warning while running usually means that the gate driver feedback has failed.

For the line converter, the detection of open thyristors is turned off when the dc link current is discontinuous because the voltage across the device does not provide a reliable indication of its conduction state when there is no current flowing. For the machine converter, all thyristor diagnostics are turned off when the motor voltage is less than 0.25 pu because the feedback from the gate drivers is not valid at low voltage.

Thyristor Diagnostics Bulletin 1557M Mini Drive

There are two differences between the Bulletin 1557M mini drive and the larger 1557 drives which affect the way thyristor failures can be detected. First, there are no thyristors connected in series, and second, there is no feedback from the gate drivers. The consequences of these differences are that the mini drive must use other feedback signals, specifically the input current and motor current, to detect open or shorted thyristors, and that failed thyristors can only be detected when the drive is started and not while it is running.

Each time the drive is started, tests are performed to detect the following thyristor failures: line converter shorted thyristor, line converter open thyristor, machine converter shorted thyristor, machine converter open thyristor. The tests are performed in the order listed, and if any failed devices are detected the remaining tests are cancelled.

Line Converter Shorted Thyristor

With the machine converter gating off, one of the six thyristors in the line converter is gated for 20 degrees at retard limit. If no devices are shorted, no current should flow. If any current is detected it indicates that the thyristor in one of the other two phases on the same side of the bridge is shorted. The test is repeated for each of the six thyristors in the line converter, and is terminated if a shorted device is found.

Line Converter Open Thyristor

For the open thyristor test, two GTOs (3 & 6) in the same phase of the machine converter are gated continuously to provide a path for dc link current which bypasses the motor. The line converter is then run briefly with the dc current below the discontinuous level. When the dc link current is discontinuous, each pair of thyristors shuts off before the next pair is gated. If no dc current is detected in two consecutive 60 degree intervals, it indicates that whichever device was gated in both those intervals did not conduct. When the test is completed, the line converter is phased back to turn off the current.

Machine Converter Shorted Thyristor

With the line converter phased back to retard limit, one of the six thyristors in the machine converter is gated. The line converter is then phased up to try to drive some current through the dc link. If no devices are shorted, no current should flow. If any current is detected, it indicates that one of the devices in the other side of the bridge is shorted. If the current flows through the motor then the shorted device must be in one of the other phases and cannot be uniquely identified. If the current does not flow through the motor then the failed device must be in the same phase as the device that is being gated. The line converter is then phased back to turn off the current. The test is repeated for each of the six thyristors in the machine converter.

The voltage across the machine side of the dc link is also measured during this test and a “No Vdc fdbk” fault is issued if no dc link voltage is detected. This usually means that the dc link voltage feedback is not connected.

Machine Converter Open Thyristor

With the line converter phased back to retard limit, both thyristors in one phase of the machine converter are gated. The line converter is then phased up to try to drive some current through the dc link. If no current is detected, it indicates that one or both devices have failed to conduct. The fault messages indicate that both devices are open, even though only one of them may be defective. This test is repeated for each of the three phases in the machine converter.

Flying Start

The 1557 drive is capable, with certain restrictions, of restarting a motor that is not stationary but is already rotating. This is a so-called flying start. In normal operation, the output of the drive is synchronized with the motor flux, which is derived from the stator voltage and current feedback. If there is no motor current, then whether the motor is rotating or stationary it does not generate any significant voltage and it is not possible to determine the stator frequency. If there is no detectable stator voltage the drive assumes that the motor is stationary, because this is the most likely case. Therefore, when the drive is started the frequency starts from an initial value of zero and ramps up until motor flux is detected. Significant flux is created in the motor only when the slip frequency (the difference between the stator frequency and rotor frequency) is small. When the drive is started with the motor stationary, the initial slip frequency is small and the motor flux builds up fairly quickly. But, if the motor is already spinning then very little flux will be induced until the stator frequency is quite close to the rotor frequency, at which time the motor flux will suddenly rise to a level sufficient for the drive to detect and synchronize itself to. If the drive reaches the commanded speed without detecting any motor flux then it will trip on a motor stall fault. There are four possible causes of a motor stall when starting:

1. The motor has pulled out and stalled during starting due to insufficient torque. The remedy for this is to increase the value of some or all of the parameters "Torque command 0", "Torque command 1", and "Acceleration time 1".
2. The motor was already rotating but the flying start failed because the drive passed through the low slip region too quickly to allow the motor flux to build up. The solution to this problem is to increase the value of parameter "Acceleration time 1". Most medium voltage motors have a rotor time constant in the range of 1 to 5 seconds and it can take a few seconds for the flux to rise to a detectable level. Until flux is detected, the drive does not use the normal speed ramp but continues to accelerate at the rate defined by parameters "Acceleration time 1" and "Ramp speed 1".
3. The motor is rotating in the direction opposite to the commanded direction of rotation. The slip frequency will increase instead of decrease as the drive accelerates and no flux will be induced in the motor.
4. The motor is rotating in the commanded direction but at a speed higher than the commanded speed. The drive will reach the commanded speed and trip before the slip frequency is low enough to induce flux in the motor.

If the motor is coasting at a high enough speed (above about 40 Hz) and the output contactor is closed, then the motor will self excite with the drive motor filter capacitors and generate a high stator voltage that the drive can detect.

If the optional tachometer feedback is installed, then the drive knows the speed of the motor at all times and can perform a flying start for any speed or direction of rotation.

With a synchronous motor, flying start is much quicker and more reliable because a detectable stator voltage is produced whenever the field is applied and the motor is rotating, even with zero stator current. When the drive is started, rated field current is applied to the motor but the stator current remains at zero until the end of the ramp start delay to allow the rotor flux to build up. If the stator frequency is greater than about 2 Hz, sufficient stator voltage is generated to allow the drive to detect the speed and direction of the motor and synchronize itself to the motor flux. If the flux feedback does not reach the level specified by parameter Flux Minimum, the drive assumes that the motor is stationary and starts from zero frequency. If the motor is not in fact stationary but is rotating very slowly, it may fail to start. If the optional position encoder is installed, a flying start can be performed for any speed or direction of rotation.

Tachometer/Encoder Option

The optional tachometer/encoder provides two significant enhancements to the drive control:

1. Provides an accurate measurement of motor speed at all times
2. Extends closed loop speed and torque control down to nearly zero speed.

A pulse tachometer, also called a pulse generator or incremental encoder, produces a pulse train output with a frequency proportional to shaft speed. The optional Tachometer Feedback board provides optically isolated inputs for up to four two-phase (quadrature) pulse tachs. Parameter Tach Select determines which one of the four tach inputs is used. Single-phase tachs can be used if reverse rotation never occurs. Parameter Tach Type specifies which type is used. The Tach Feedback board contains counters that count the number of tach pulses produced during a specified time interval. Dividing the number of tach pulses by the sampling period yields the tach output frequency, from which the shaft speed can be calculated using the tach pulses per revolution (ppr) specified by parameter Tach Pulse/Rev and the number of motor poles. The shaft speed is measured six times per cycle for stator frequencies above 10 Hz, and at a fixed rate of 60 times per second for lower frequencies. This is a lower sample rate than used by most low voltage drives. The tach resolution determines the minimum motor speed that can be measured. If high starting torque or very low speed operation is required then a high resolution such as 1024 or 2048 ppr must be provided. Otherwise, a low resolution such as 240 or 360 ppr is adequate.

In order to control motor flux and torque, the machine converter gating must be synchronized with the rotor flux. Over most of the speed range, the machine converter gating is synchronized to the rotor flux signal reconstructed from the stator voltage and current feedback by analog hardware (refer to p. 5-18). Because the rotor flux is measured, this method is called direct vector control. However, the analog flux signal is not usable for stator frequencies less than about 5 Hz. To control flux and torque at low speeds, the 1557 drive switches to indirect vector control, which is widely used in low voltage drives. With indirect control the position of the rotor flux is not directly measured but is indirectly predicted by adding the calculated slip angle to the measured rotor angle. The rotor angle is obtained by integrating the output of the pulse tach (the zero position is arbitrary). The slip frequency required to provide the desired flux and torque is calculated from the d-axis and q-axis current commands and the rated slip frequency. The slip frequency is integrated to get the slip angle and added to the measured rotor angle to obtain the flux angle. Indirect control can be used at any speed but its weakness is that the calculated slip is sensitive to errors in the motor parameters. Errors in slip frequency increase the coupling between flux and torque which adversely affects the stability of the flux control. Since large motors generally have lower magnetizing current and lower slip than small motors they are more sensitive to parameter errors (i.e. a small error in slip produces a large error in torque and flux).

Because of its salient pole construction, the position of the rotor flux in a synchronous machine is not arbitrary but is determined by the physical position of the rotor. A synchronous machine therefore requires an absolute position encoder instead of an incremental encoder for indirect vector control. The encoder must also be aligned with the direct axis of the rotor. To avoid having to physically align the encoder, an offset angle specified by parameter Encoder Offset is added to the encoder output to compensate for the difference between the encoder zero and the direct axis of the rotor. Parameter Encoder Reverse is provided to reverse the encoder rotation in software if it does not match the rotation of the motor.

The encoder output must be Gray code and not normal binary. In most cases the encoder will actually have a 10 or 12-bit parallel output, but the Tach Feedback board can only accommodate 8 bits. Which 8 bits are used is determined by the number of motor poles and is shown on the electrical drawings. There is no parameter to specify the encoder resolution; it is inferred from the number of motor poles.

Parameter and Variable Descriptions

Firmware Revisions 4.72 & 5.32

Important Notice: With the introduction of the new 18-pulse control boards, the Drive Control firmware has been split into two parallel versions. Firmware revisions below 5.00 can only be used in the original Drive Control board 80165-108-51. Firmware revision 5.00 and above can only be used in the new 18-Pulse Drive Control board 80190-118-51. Although every effort has been made to make them as similar as possible, the two versions of firmware are **definitely not interchangeable** and **will not function** if installed in the wrong type of Drive Control board.

The drive control firmware provides over two hundred parameters and variables that are accessible to the user. Parameters are user adjustable constants such as ramp times or trip levels that are saved in nonvolatile (EE) memory when the control power is off. Variables are values such as speed reference or current feedback that cannot be changed by the user. Parameters and variables are grouped and described separately. For example, there is a group of parameters for the speed control function and there is also a separate group of variables for the speed control function.

Parameter Descriptions

The drive parameters are described in this section. The parameter descriptions are arranged in the functional groups used by the programming terminal. Each description begins with the full name of the parameter, followed by the name displayed on the programming terminal. The linear number of the parameter is given followed by the minimum and maximum values showing the position of the decimal point and the units if applicable. Next is the default value that is assigned when a parameter initialization is performed. Finally, there is a short description of the function of the parameter. Unless stated otherwise, all parameters are saved in nonvolatile memory.

1 Feature Select Parameters

Contactor Configuration [Contactor config]

Linear number: 1
 Minimum value: 0
 Maximum value: 7
 Default value: 0

This parameter specifies the contactor configuration, specifically under what conditions the input and output contactors will be open. The possible contactor configurations specified by this parameter are:

	<u>Input Contactor</u>	<u>Output Contactor</u>
0	Open when not running	Open when not running
1	Open for all faults	Open when not running
2	Open when not running	Open for all faults
3	Open for all faults	Open for all faults
4	Open when not running	Open when not running
5	Open for critical faults only	Open when not running
6	Open when not running	Open for all faults
7	Open for critical faults only	Open for all faults

Critical faults are line overcurrent, DC link overcurrent, and line overvoltage. If an input or output contactor is not provided, the "close contactor" discrete output should be connected to the corresponding "contactor closed" discrete input.

Provision for keeping the contactors closed for all except critical faults was added in Rev 4.40/5.10.

Automatic Restart Delay [Auto restart dly]

Linear number: 3
 Minimum value 0.000 sec
 Maximum value: 10.000 sec
 Default value: 0.000 sec

This parameter specifies the time interval after a line voltage outage during which the drive will automatically restart if the line voltage is restored, assuming that the drive was running at the time of the outage. *The drive will restart only if control power is maintained during the outage.*

Test Mode [Test mode]

Linear number: 4
 Minimum value 0
 Maximum value: 4
 Default value: 0

This parameter specifies the drive test mode. It is not saved and is set to zero at power up. If this parameter is changed when the drive is running, the change will not take effect until the drive is stopped.

- 0 normal operating mode
- 1 gate test mode (medium voltage off)
- 2 dc current test mode
- 3 system test mode
- 4 open circuit test mode

Refer to Chapter 5 for a description of the test modes.

Speed Command Select 0 [Spd cmd select 0]

Linear number: 6
 Minimum value 1
 Maximum value: 15
 Default value: 1

This parameter specifies the speed command that is selected when parameter Speed Command Select has a value of 1. The 11 possible sources of speed command that can be selected by this parameter are:

- 1 Speed Command 0 (analog input 1L)
- 2 Preset Speed Command 1
- 3 Preset Speed Command 2
- 4-8 Preset Speed Command 3
- 9 Speed Command 8 (analog input 1M)
- 10 SCANport adapter 1 (Communications Processor board Port 1)
- 11 SCANport adapter 2 (Communications Processor board Port 2)
- 12 SCANport adapter 3 (not used)
- 13 SCANport adapter 4 (not used)
- 14 SCANport adapter 5 (not used)
- 15 SCANport adapter 6 (1336-GM1 RI/O adapter)

[This parameter was added in Rev 4.62/5.11 and replaces parameter Default Speed Command Select.](#)

Speed Command Select 8 [Spd cmd select 8]

Linear number: 9
 Minimum value 1
 Maximum value: 15
 Default value: 9

This parameter specifies the speed command that is selected when parameter Speed Command Select has a value of 9. The possible sources of speed command that can be selected by this parameter are the same as parameter Speed Command Select 0.

[This parameter was added in Rev 4.62/5.11.](#)

Speed Command Select [Speed cmd select]

Linear number: 7
 Minimum value: 0
 Maximum value: 15
 Default value: N/A

This parameter specifies the source of the drive speed command. It is not saved and is set to either 1 (Local) or 9 (Remote) at power up depending on the state of the Local/Remote digital input. The 11 possible sources of speed command that can be selected by this parameter are:

- 0 none
- 1 Speed Command Select 0 (Local)
- 2 Preset Speed Command 1
- 3 Preset Speed Command 2
- 4-8 Preset Speed Command 3
- 9 Speed Command Select 8 (Remote)
- 10 SCANport adapter 1 (Communications Processor board Port 1)
- 11 SCANport adapter 2 (Communications Processor board Port 2)
- 12 SCANport adapter 3 (not used)
- 13 SCANport adapter 4 (not used)
- 14 SCANport adapter 5 (not used)
- 15 SCANport adapter 6 (1336-GM1 R/I/O adapter)

Reverse Enable [Reverse enable]

Linear number: 8
 Minimum value: 0
 Maximum value: 1
 Default value: 0 (Off)

This parameter is used to prevent the drive from running in the reverse direction. When this parameter is set to zero, the *commanded* direction of rotation is always forward.

Note that this does not prevent reverse rotation if the load overpowers the drive.

Input Contactor Opening Delay [Input open delay]

Linear number: 10
 Minimum value: 0.0 min.
 Maximum value: 57.0 min.
 Default value: 0.0 min.

This parameter specifies the time delay between the drive shutting off, and the input contactor opening, if the contactor is configured to open when the drive is not running. The purpose of this delay is to keep a harmonic filter energized if the drive is stopped for a short time, and not have to wait for the filter capacitors to discharge before restarting.

Parameter Level [Parameter level]

Linear number: 13
 Minimum value: 0
 Maximum value: 3
 Default value: 2

This parameter specifies which of the parameters and variables are visible:

- 0 Minimum
- 1 Standard
- 2 Full
- 3 Development

Parameters that are not visible are set to their default value. If this parameter is changed, the new value will not take effect until the control power is turned off and on.

[This parameter was added in Rev 5.00 and is not present in 4.xx.](#)

Drive Control Firmware Revision Number [Drive contrl FRN]

Linear number: 15
Minimum value: 0.00
Maximum value: 99.99
Default value: N/A

This parameter specifies the revision of firmware installed in the Drive Control boards. Changing the value of this parameter has no effect.

Prior to Rev 4.60/5.10, this parameter was called simply "Firmware Revision".

Communications Processor Firmware Revision Number [Comm proc FRN]

Linear number: 16
Minimum value: 0.00
Maximum value: 99.99
Default value: N/A

This parameter specifies the revision of firmware installed in the Communications Processor board. Changing the value of this parameter has no effect.

This parameter was added in Rev 4.60/5.10.

2 Nameplate Parameters**Rated Line Frequency [Rated line freq]**

Linear number: 17
Minimum value: 50 Hz
Maximum value: 60 Hz
Default value: 60 Hz

This parameter specifies the rated frequency of the drive, and must be set to either 50 Hz or 60 Hz.

Capacitor kvar [Capacitor kvar]

Linear number: 20
Minimum value: 1 kvar
Maximum value: 7500 kvar
Default value: 100 kvar

This parameter specifies the total three phase nameplate kvar of the motor filter capacitors.

Capacitor Volts [Capacitor volts]

Linear number: 21
Minimum value: 1000 V
Maximum value: 10000 V
Default value: 2400 V

This parameter specifies the nameplate voltage rating of the motor filter capacitors. If the rated capacitor voltage is less than the rated motor voltage then the drive assumes that the capacitors are connected in wye and multiplies the rated capacitor voltage by $\sqrt{3}$. Otherwise the drive assumes that the capacitors are connected in delta and uses this parameter unchanged.

Prior to Rev 4.60/5.10, this parameter specified line to line rated voltage regardless of the capacitor connection.

Capacitor Frequency [Capacitor freq]

Linear number : 28
Minimum value: 50 Hz
Maximum value: 60 Hz
Default value: 60 Hz

This parameter specifies the rated nameplate frequency of the motor filter capacitors (50 Hz or 60 Hz). This parameter has been included to eliminate the requirement to recalculate the capacitor kvar when the capacitor rated frequency is not the same as line frequency.

Rated Motor Volts [Rated motor volt]

Linear number: 22
Minimum value: 1000 V
Maximum value: 7200 V
Default value: 2300 V

This parameter specifies the rated line to line voltage of the motor. It is used along with the known divider ratios of the voltage feedback boards to calculate the motor voltage feedback scaling. 1.0 per unit voltage is defined as equal to this parameter.

The motor rated voltage should be specified as 2300/4000V and not 2400/4160V to ensure that the line voltage is slightly higher than the motor voltage. Since the motor voltage is limited by the line voltage, increasing the motor rated voltage in an attempt to get more out of the drive will only force the drive to go into field weakening at a lower speed.

Rated Motor Amps [Rated motor amps]

Linear number: 23
Minimum value: 10 A
Maximum value: 1000 A or 1400 A (FRN 5.30)
Default value: 60 A

This parameter specifies the rated full load current of the motor. 1.0 per unit current is defined as equal to this parameter multiplied by the service factor parameter. If, as often happens, the motor rated current for a service factor of 1.0 is entered, and it is later determined that the motor is undersized and it is necessary to operate at a higher service factor, it is better to change the service factor parameter instead of this parameter. Changing the motor rated current changes the base impedance of the motor, meaning that the drive must be retuned.

Rated Motor kw [Rated motor kw]

Linear number: 24
Minimum value: 30 kw
Maximum value: 7500 kw or 10000 kw (FRN 5.30)
Default value: 187 kw

This parameter specifies the rated power of the motor. This parameter and the following parameter are actually the same parameter with different scaling. Either parameter may be set and the other will automatically change to the corresponding value in the alternative units.

Rated Motor hp [Rated motor hp]

Linear number: 25
Minimum value: 40 hp
Maximum value: 10000 hp or 13400 hp (FRN 5.30)
Default value 250 hp

This parameter specifies the rated power of the motor. This parameter and the preceding parameter are actually the same parameter with different scaling. Either parameter may be set and the other will automatically change to the corresponding value in the alternative units.

Rated Motor rpm [Rated motor rpm]

Linear number: 26
Minimum value: 150.0 rpm
Maximum value: 3600.0 rpm
Default value: 1185.0 rpm

This parameter specifies the rated full load speed of the motor in rpm. It is equal to synchronous speed for a synchronous motor and slightly less than synchronous speed for an induction motor. A “rated rpm” warning will be displayed if this parameter is entered incorrectly.

Rated Motor Frequency [Rated motor freq]

Linear number: 29
Minimum value: 40 Hz
Maximum value: 90 Hz
Default value: 60 Hz

This parameter specifies the frequency corresponding to the rated motor rpm specified by the previous parameter. It is included for the situation in which the motor rated frequency is not the same as the line rated frequency (e.g. a 60 Hz motor on a 50 Hz supply). The rated frequency of the drive is still the rated line frequency.

Motor Type [Motor type]

Linear number: 30
Minimum value: 0
Maximum value: 1
Default value: 0

This parameter specifies the type of motor connected to the drive.

0 induction (asynchronous)
1 synchronous

[This parameter was added in Rev 5.00 and is not present in 4.xx.](#)

Drive Type [Drive type]

Linear number: 32
Minimum value: 0
Maximum value: 1
Default value: 0

This parameter specifies the type of drive.

0 Bulletin 1557 (all versions)
1 Powerflex 7000

[This parameter was added in Rev 5.30 and is not present in 4.xx.](#)

Link Inductance [Link inductance]

Linear number: 27
Minimum value: 1.0 mH
Maximum value: 600.0 mH
Default value: 64.0 mH

This parameter specifies the nameplate value of the dc link inductor in mH (total for both coils).

Service Factor [Service Factor]

Linear number: 31
Minimum value: 0.75
Maximum value: 1.25
Default value: 1.0

This parameter specifies the service factor of the motor. Because the motor parameters are normalized to the service factor, changing this parameter allows the motor rating to be changed without affecting the drive tuning.

[This parameter was added in Rev 4.55/5.00.](#)

3 Speed Command Parameters**Preset Speed Command 1-3 [Preset speed 1-3]**

Linear numbers: 33-35
 Minimum value: 0.5 Hz
 Maximum value: 90.0 Hz
 Default values: 30.0/40.0/50.0 Hz

These three parameters specify preset speed commands that can be selected by the logic command word.

Preset Jog Speed [Preset jog speed]

Linear number: 40
 Minimum value: 1 Hz
 Maximum value: 60 Hz
 Default value: 6.0 Hz

This parameter specifies the preset jog speed command, which is selected by the logic command word.

Speed Command 0 Minimum [Speed cmd 0 min]

Linear number: 41
 Minimum value: -127.0 Hz
 Maximum value: 127.0 Hz
 Default value: 6.0 Hz

This parameter specifies the value of speed command corresponding to 0.00V on analog input 1L. The required value can be calculated using the following formula:

$$\text{Speed cmd 0 min} = f_{\text{min}} - [v_{\text{min}} \times (f_{\text{max}} - f_{\text{min}}) / (v_{\text{max}} - v_{\text{min}})]$$

f_{min} is the minimum operating speed
 f_{max} is the maximum operating speed
 v_{min} is the voltage corresponding to minimum operating speed
 v_{max} is the voltage corresponding to maximum operating speed

Speed Command 0 Maximum [Speed cmd 0 max]

Linear number: 42
 Minimum value: 0.0 Hz
 Maximum value: 127.0 Hz
 Default value: 60.0 Hz

This parameter specifies the value of speed command corresponding to 10.00V on analog input 1L. It may be less than Speed Command 0 Minimum. The required value can be calculated using the following formula:

$$\text{Speed cmd 0 max} = f_{\text{min}} + [(10V - v_{\text{min}}) \times (f_{\text{max}} - f_{\text{min}}) / (v_{\text{max}} - v_{\text{min}})]$$

The terms are as defined in the description of parameter Speed Command 0 Minimum.

Speed Command 8 Minimum [Speed cmd 8 min]

Linear number: 43
 Minimum value: -127.0 Hz
 Maximum value: 127.0 Hz
 Default value: 6.0 Hz

This parameter specifies the value of speed command corresponding to 0.00V on analog input 1M. The required value can be calculated as described for parameter Speed Command 0 Minimum.

Speed Command 8 Maximum [Speed cmd 8 max]

Linear number: 44
 Minimum value: 0.0 Hz
 Maximum value: 127.0 Hz
 Default value: 60.0 Hz

This parameter specifies the value of speed command corresponding to 10.00V on analog input 1M. It may be less than Speed Command 8 Minimum. The required value can be calculated as described for parameter Speed Command 0 Maximum.

Speed Command 9 Minimum [Speed cmd 9 min]

Linear number: 45
 Minimum value: 127.0 Hz
 Default value: 6.0 Hz

This parameter specifies the value of speed command corresponding to a digital speed command input of 0. The required value can be calculated using the following formula:

$$\text{Speed cmd 9 min} = f_{\text{min}} + [v_{\text{min}} \times (f_{\text{max}} - f_{\text{min}}) / (v_{\text{max}} - v_{\text{min}})]$$

f_{min} is the minimum operating speed
 f_{max} is the maximum operating speed
 v_{min} is the value corresponding to minimum operating speed
 v_{max} is the value corresponding to maximum operating speed

Speed Command 9 Maximum [Speed cmd 9 max]

Linear number: 46
 Minimum value: 0.0 Hz
 Maximum value: 127.0 Hz
 Default value: 60.0 Hz

This parameter specifies the value of speed command corresponding to a digital speed command input of 32767. It may be less than Speed Command 9 Minimum. The required value can be calculated using the following formula:

$$\text{Speed cmd 9 max} = f_{\text{min}} + [(32767 - v_{\text{min}}) \times (f_{\text{max}} - f_{\text{min}}) / (v_{\text{max}} - v_{\text{min}})]$$

The terms are as defined in the description of parameter Speed Command 9 Minimum.

Speed Command Minimum [Speed cmd min]

Linear number: 47
 Minimum value: 1.0 Hz
 Maximum value: 75.0 Hz
 Default value: 6.0 Hz

This parameter specifies the minimum value of the speed command. When the drive is running, the absolute value of the speed command will not be less than this value regardless of the other parameter settings (except for Speed Command Maximum).

Speed Command Maximum [Speed cmd max]

Linear number: 48
 Minimum value: 1.0 Hz
 Maximum value: 75.0 Hz
 Default value: 60.0 Hz

This parameter specifies the maximum value of the speed command. The absolute value of the speed command will not be greater than this value regardless of the other parameter settings (including Speed Command Minimum).

4 Skip Speed Parameters**Skip Speed 1-4 [Skip speed 1-4]**

Linear numbers: 49-52
 Minimum value: 6.0 Hz
 Maximum value: 90.0 Hz
 Default value: 90.0 Hz

These four parameters specify the center of the skip speed zones.

Skip Speed Band 1-4 [Skip spd band 1-4]

Linear numbers: 53-56
Minimum value: 0.0 Hz
Maximum value: 2.0 Hz
Default value: 0.0 Hz

These four parameters specify the width of the skip speed zones.

5 Speed Ramp Parameters**Acceleration Time 1 [Accel time 1]**

Linear number: 65
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 5 sec

This parameter specifies the time for the speed reference to increase from zero to Ramp Speed 1.

Acceleration Time 2 [Accel time 2]

Linear number: 66
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 3 sec

This parameter specifies the time for the speed reference to increase from Ramp Speed 1 to Ramp Speed 2.

Acceleration Time 3 [Accel time 3]

Linear number: 67
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 14 sec

This parameter specifies the time for the speed reference to increase from Ramp Speed 2 to Ramp Speed 3.

Acceleration Time 4 [Accel time 4]

Linear number: 68
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 3 sec

This parameter specifies the time for the speed reference to increase from Ramp Speed 3 to Ramp Speed 4.

Deceleration Time 1 [Decel time 1]

Linear number: 69
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 3 sec

This parameter specifies the time for the speed reference to decrease from Ramp Speed 1 to zero.

Deceleration Time 2 [Decel time 2]

Linear number: 70
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 3 sec

This parameter specifies the time for the speed reference to decrease from Ramp Speed 2 to Ramp Speed 1.

Deceleration Time 3 [Decel time 3]

Linear number: 71
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 14 sec

This parameter specifies the time for the speed reference to decrease from Ramp Speed 3 to Ramp Speed 2.

Deceleration Time 4 [Decel time 4]

Linear number: 72
Minimum value: 0 sec
Maximum value: 999 sec
Default value: 3 sec

This parameter specifies the time for the speed reference to decrease from Ramp Speed 4 to Ramp Speed 3.

Ramp Speed 1 [Ramp speed 1]

Linear number: 73
Minimum value: 5.0 Hz
Maximum value: 6.0 Hz
Default value: 5.0 Hz

This parameter specifies the first break point in the speed ramp and also the speed at which the drive switches between starting mode and normal running mode. *THIS PARAMETER IS SET AT THE FACTORY AND SHOULD NOT BE CHANGED WITHOUT CONSULTING THE FACTORY.*

Ramp Speed 2 [Ramp speed 2]

Linear number: 74
Minimum value: 5.0 Hz
Maximum value: 100.0 Hz
Default value: 12.0 Hz

This parameter specifies the second break point in the speed ramp. It must be greater than Ramp Speed 1.

Ramp Speed 3 [Ramp speed 3]

Linear number: 75
Minimum value: 5.0 Hz
Maximum value: 100.0 Hz
Default value: 54.0 Hz

This parameter specifies the third break point in the speed ramp. It must be greater than Ramp Speed 2.

Ramp Speed 4 [Ramp speed 4]

Linear number: 76
Minimum value: 5.0 Hz
Maximum value: 100.0 Hz
Default value: 60.0 Hz

This parameter specifies the fourth break point in the speed ramp. It must be greater than Ramp Speed 3.

Coast Speed [Coast speed]

Linear number: 77
Minimum value: 2 Hz
Maximum value: 100 Hz
Default value: 2 Hz

This parameter specifies the speed at that the drive shuts off and coasts when stopping.

Ramp Start Delay [Ramp start delay]

Linear number: 78
Minimum value: 1 sec
Maximum value: 10 sec
Default value: 3 sec

This parameter specifies the time the speed reference remains at zero after the drive is started. The purpose of the delay is to allow flux to be established in the motor before attempting to accelerate. If the torque required at starting is very low then this parameter can be set to a small value such as 1 second, but should be set to a higher value if high starting torque is required. This parameter is active even when tach feedback is enabled.

Ramp Test Step [Ramp test step]

Linear number: 80
Minimum value: 0.0 Hz
Maximum value: 30.0 Hz
Default value: 0.0 Hz

This parameter specifies the magnitude of the step that is added to the speed command to demonstrate the response of the speed ramp. If this parameter is set to a non zero value, the drive will continuously ramp up and down between a maximum speed equal to the speed command plus the value of this parameter, and a minimum value equal to the speed command minus the value of this parameter. *The ramp test function is intended to be used in factory test only.* This parameter is not saved and is initialized to zero at power up.

6 Speed Control Parameters**Speed Regulator Bandwidth [Spdreg bandwidth]**

Linear number: 81
Minimum value: 0.5 r/s
Maximum value: 5.0 r/s
Default value: 1.0 r/s

This parameter specifies the small signal bandwidth of the speed control loop. It is used in the calculation of the speed regulator gains. This parameter affects only the response time of the speed regulator and not the overshoot. The speed regulator bandwidth will automatically be reduced to limit the bandwidth-inertia product to a maximum of 30.

Total inertia [Total inertia]

Linear number: 82
Minimum value: 0.10 sec
Maximum value: 100.00 sec
Default value: 1.00 sec

This parameter specifies the total inertia of the motor and load, which is defined as the time required to accelerate to rated speed at rated torque. This parameter replaces the mechanical time constant parameter used in firmware revisions prior to 4.00. When upgrading the firmware, either the speed regulator should be retuned or the inertia can be calculated using the following relationship between the old and new parameters:

$$\text{Total inertia} = 1.47 \times T_{\text{mechanical}}^2$$

Torque Rate Limit [Trq rate limit]

Linear number: 83
Minimum value: 0.00
Maximum value: 60.00
Default value: 10.00

This parameter specifies the maximum change allowed in the torque command in one second. The purpose of this parameter is to prevent rapid changes in motor torque that might damage shafts and couplings. A value of 1.00 corresponds to rated motor torque in one second. Setting the torque rate limit too low will cause the speed regulator to overshoot.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit per cycle and was a much smaller number.

Torque Limit Motoring [Trq lmt motoring]

Linear number: 84
Minimum value: 0.00
Maximum value: 1.50
Default value: 1.00

This parameter specifies the maximum value of the torque command when motoring. A value of 1.00 corresponds to rated motor torque.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Torque Limit Braking [Trq lmt braking]

Linear number: 85
Minimum value: 0.00
Maximum value: 1.50
Default value: 0.80

This parameter specifies the maximum value of the torque command when braking or generating. A value of 1.00 corresponds to rated motor torque.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Torque Command 0 [Trq command 0]

Linear number: 86
Minimum value: 0.00
Maximum value: 1.50
Default value: 0.15

This parameter specifies the value of the torque command at zero speed used in starting mode. It may be higher or lower than Torque Command 1. If this parameter is set too low the motor may not start. If it is set too high the start will be excessively rough and noisy. A value of 1.00 corresponds to rated motor torque. This parameter has no effect if the optional tach feedback is enabled.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Torque Command 1 [Trq command 1]

Linear number: 87
Minimum value: 0.00
Maximum value: 1.50
Default value: 0.15

This parameter specifies the value of the torque command at Ramp Speed 1 and above used in starting mode. It may be higher or lower than Torque Command 0. In starting mode, the torque command changes linearly from Torque Command 0 at zero speed to Torque Command 1 at Ramp Speed 1. When the drive switches from starting mode to normal running mode and the speed regulator is released, the torque command is initially equal to the value of this parameter. If it is set too low the motor may stall before the speed regulator has time to increase the torque command. If it is set too high, the motor will accelerate very rapidly after the transition until the speed regulator is able to decrease the torque command to the value required to follow the speed ramp. A value of 1.00 corresponds to rated motor torque. This parameter has no effect if the optional tach feedback is enabled.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Speed Reference Step [Speed ref step]

Linear number: 88
Minimum value: 0.0 Hz
Maximum value: 2.0 Hz
Default value: 0.0 Hz

This parameter specifies the magnitude of the step that is added to the speed error to demonstrate the step response of the speed loop. It is not saved and is initialized to zero at power up.

Speed Feedback Mode [Speed fdbk mode]

Linear number: 89
Minimum value: 0
Maximum value: 1
Default value: 0

This parameter specifies the type of speed feedback used.

- 0 stator frequency with slip compensation
- 1 tachometer/encoder

The drive automatically switches to stator frequency feedback when a tach loss fault occurs. If the tach loss fault is successfully cleared the drive switches back to tach feedback mode.

Torque Control Mode [Trq control mode]

Linear number: 90
Minimum value: 0
Maximum value: 5
Default value: 1

This parameter specifies the torque control mode.

- 0 zero torque
- 1 speed regulator
- 2 external torque command
- 3 speed regulator with external positive torque limit
- 4 speed regulator with external negative torque limit
- 5 sum of speed regulator and external torque command

Torque Command External [Trq command ext]

Linear number: 91
Minimum value: -1.500
Maximum value: 1.500
Default value: 0.000

The function of this parameter depends on the torque control mode:

- 0 not used
- 1 not used
- 2 torque command
- 3 positive torque limit
- 4 negative torque limit
- 5 torque command

A value of 1.00 corresponds to rated motor torque. Note that motoring torque is positive for forward rotation and negative for reverse rotation.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Torque Command Minimum [Trq command min]

Linear number: 92
Minimum value: 0.00
Maximum value: 1.50
Default value: 1.50

This parameter specifies the minimum initial value of the torque reference when the speed regulator is enabled. When starting a drive without tach feedback, the actual motor torque is measured and the torque reference is set to an appropriate value before enabling the speed regulator. This is intended to reduce the speed overshoot that can occur when Torque Command 1 is set too high. A value of 1.00 corresponds to rated motor torque. This parameter has no effect when tach feedback is enabled.

The default setting disables this load dependent initialization of the torque reference. If this starting torque adjustment function is required, "Torque Command Minimum" should be set to a value lower than "Torque Command 1".

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Speed Error Deadband [Spd err deadband]

Linear number: 93
Minimum value: 0.0 Hz
Maximum value: 5.0 Hz
Default value: 0.0 Hz

This parameter specifies a deadband for the speed regulator error. If the absolute value of the speed error is less than the value of this parameter, the output of the speed regulator will not change. This parameter is intended to be used only in torque control mode 5, and should be left at its default value of zero in all other torque control modes.

Speed Feedback Filter [Spd fdbk filter]

Linear number: 110
Minimum value: 0 r/s
Maximum value: 50 r/s
Default value: 0 r/s

This parameter specifies the bandwidth of a second order low pass filter for the motor speed feedback. The purpose of this filter is to attenuate any undesirable components, such as mechanical resonant frequencies, in the speed feedback. Normally, this parameter should be left at its default value of zero, which automatically selects a filter bandwidth equal to ten times the speed regulator bandwidth. At this setting, the filter will have no noticeable affect on the response of the speed regulator, but as the filter bandwidth decreases below this value, the speed regulator becomes more underdamped until it eventually becomes unstable.

This parameter was added in Rev 4.60/5.10.

Torque Rate Limit 0 [Trq rate limit 0]

Linear number: 111
Minimum value: 0.00
Maximum value: 60.00
Default value: 1.00

This parameter specifies the maximum change allowed in the torque command in one second during open loop starting. The purpose of this parameter is to allow torque to be applied slowly when starting to avoid exciting the torsional natural frequency of the mechanical system. This parameter is used only during open loop starting. The normal Torque Rate Limit parameter is used when running and when starting with the optional tach feedback enabled.

This parameter was added in Rev 4.72/5.20

7 Flux Control Parameters

Flux Regulator Bandwidth [Flxreg bandwidth]

Linear number: 97
Minimum value: 1 r/s
Maximum value: 30 r/s
Default value: 10 r/s

This parameter specifies the small signal bandwidth of the flux control loop. It is used in the calculation of the flux regulator gain. The maximum bandwidth possible for stable flux control tends to decrease as motor size increases.

Base Speed [Base speed]

Linear number: 98
Minimum value: 30.0 Hz
Maximum value: 100.0 Hz
Default value: 60.0 Hz

This parameter specifies the frequency at which field weakening begins. Base Speed is normally set equal to the rated frequency of the motor. It can be set to a lower value only if the motor is specially designed to operate at a higher than normal flux level without saturating.

Flux Command Base Speed [Flx cmd base spd]

Linear number: 100
Minimum value: 0.300 pu
Maximum value: 1.500 pu
Default value: 0.900 pu

This parameter specifies the value of the flux command at base speed and rated load. The flux command will never be greater than this parameter, which can be set manually or by autotuning.

Flux Reference Step [Flx ref step]

Linear number: 102
Minimum value: 0.000 pu
Maximum value: 0.100 pu
Default value: 0.000 pu

This parameter specifies the magnitude of the step that is added to the flux reference to demonstrate the step response of the flux loop. It is not saved and is initialized to zero at power-up.

Flux Command No Load [Flx Cmd no load]

Linear number: 103
Minimum value: 0.300 pu.
Maximum value: 1.500 pu
Default value: 0.700 pu

This parameter specifies the value of the flux command at no load. The flux command will change linearly from Flux Command No Load to Flux Command Base Speed as Torque Reference changes from 0.00 to 1.00. Reducing the motor flux improves efficiency when running for extended periods at less than full load. The maximum torque capability of the drive is reduced in proportion to the reduction in flux. If the load increases suddenly when the drive is running with reduced flux, there may be a large drop in speed until the flux can be restored to its normal level. If Flux Command No Load is set higher than Flux Command Base Speed, the flux command will not vary with load.

Note: For Bulletin 1557M drives, this parameter is internally limited to 0.600 pu maximum.

If Command Bandwidth [If cmd bandwidth]

Linear number: 104
 Minimum value: 0.1 r/s
 Maximum value: 10.0 r/s
 Default value: 1.0 r/s

This parameter specifies the bandwidth of the field current command for synchronous motors. It should be set to a value that is less than the bandwidth of both the flux regulator and the field current control.

This parameter was added in Rev 5.00 and is not present in 4.xx.

Icd Command Gain [Icd command gain]

Linear number: 105
 Minimum value: 0.0
 Maximum value: 1.0
 Default value: 0.5

This parameter specifies the gain of the capacitor current compensation for synchronous motors. When this parameter is set to its minimum value of 0.0, all the current for the motor filter capacitor is supplied by the drive. The line current is higher than the motor current and the motor operates at approximately unity power factor. When this parameter is set to its maximum value of 1.0, all the current for the motor filter capacitor is supplied by the motor. The line current is less than the motor current and the motor operates at a lagging power factor with reduced field current. When this parameter is set to its default value of 0.5, approximately half the motor filter capacitor current is supplied by the drive and half by the motor. The line current and the motor current are approximately equal and the motor power factor is slightly lagging. This parameter is not used for induction motors.

This parameter was added in Rev 5.10 and is not present in 4.xx.

8 Current Control Parameters**Current Regulator Bandwidth [Curreg bandwidth]**

Linear number: 113
 Minimum value: 0 r/s
 Maximum value: 400 r/s
 Default value: 200 r/s

This parameter specifies the small signal bandwidth of the current control loop. It is used in the calculation of the current regulator gain. This parameter affects only the response time of the current regulator and not the overshoot. It is normally set to 200 radian/second.

DC Link Inductance [L DC link]

Linear number: 114
 Minimum value: 0.00 pu
 Maximum value: 10.0 pu
 Default value: N/A

This parameter specifies the per unit dc link inductance calculated from the nameplate link inductance and the voltage and current ratings of the drive. It is not saved and is recalculated when any of the parameters affecting its value are changed.

DC Link Time Constant [T DC link]

Linear number: 115
 Minimum value: 0.010 sec
 Maximum value: 0.100 sec
 Default value: 0.040 sec

This parameter specifies the time constant of the dc current regulator. It affects both the response time and overshoot of the regulator, and should be adjusted to produce a step response that has zero or a very small overshoot. This parameter can be set manually or by autotuning.

Commutation Inductance [L commutation]

Linear number: 117
Minimum value: 0.00 pu
Maximum value: 0.50 pu
Default value: 0.10 pu

This parameter specifies the commutating inductance of the line converter. This is roughly equal to the impedance of the supply, including the isolating transformer if present, expressed in the per unit system of the drive. The commutating inductance is used in the hardware reconstruction of the line voltage to compensate for commutation notches. It is also used in the calculation of the retard limit for the line converter. This parameter can be set manually or by autotuning.

DC Current Test Command [Idc command test]

Linear number: 119
Minimum value: 0.000 pu
Maximum value: 1.000 pu
Default value: 0.000 pu

This parameter specifies the value of the dc current command when the drive is operating in dc current test mode. It is not saved and is initialized to zero at power up.

DC Current Reference Step [Idc ref step]

Linear number: 120
Minimum value: 0.000 pu
Maximum value: 1.000 pu
Default value: 0.000 pu

This parameter specifies the magnitude of the step that is added to the dc current command to demonstrate the step response of the current loop. It is not saved and is initialized to zero at power-up.

9 Motor Model Parameters**Stator Resistance [R stator]**

Linear number: 129
Minimum value: 0.00 pu
Maximum value: 0.20 pu
Default value: 0.00 pu

This parameter specifies the per unit stator resistance of the motor. It is used in the calculation of the stator voltage and in the hardware reconstruction of the rotor flux. Stator resistance is usually less than 0.01 pu unless the motor is very small or the motor cables are very long. This parameter can be set manually or by autotuning.

Warning: An excessively high stator resistance may cause the drive to become unstable at low speed high load.

Total Leakage Inductance [L total leakage]

Linear number: 130
Minimum value: 0.00 pu
Maximum value: 0.74 pu
Default value: 0.20 pu

This parameter specifies the per unit total leakage, short circuit, or transient inductance (L_s') of the motor. It is approximately equal to the sum of the stator and rotor leakage inductance's, and the cable inductance, and has a typical value of 0.20 pu. The leakage inductance parameter is used in the calculation of the stator voltage and in the hardware reconstruction of the rotor flux. This parameter can be set manually or by autotuning.

Warning: An excessively high leakage inductance may cause the drive to become unstable at high speed high load.

Magnetizing Inductance [L magnetizing]

Linear number: 131
Minimum value: 1.00 pu
Maximum value: 15.00 pu
Default value: 4.00 pu

This parameter specifies the per unit motor magnetizing inductance. Typical values of this parameter are in the range 2.0 pu to 6.0 pu for induction motors and 1.0 pu to 2.0 pu for synchronous motors. Magnetizing inductance can change significantly with changes in load and flux. This parameter can be set manually or by autotuning.

Rotor Time Constant [T rotor]

Linear number: 132
Minimum value: 0.10 sec
Maximum value: 10.00 sec
Default value: 1.00 sec

This parameter specifies the rotor time constant of the motor. Typical values are in the range 1.0 to 2.0 sec. The rotor time constant varies significantly with rotor temperature (due to the change in rotor resistance), which has some effect on the response of the flux regulator and the calculation of the slip frequency for induction motors. This parameter can be set manually or by autotuning.

Filter Capacitor [Filter capacitor]

Linear number: 133
Minimum value: 0.00 pu
Maximum value: 2.00 pu
Default value: 0.42 pu

This parameter specifies the per unit effective motor filter capacitance calculated from the capacitor nameplate parameters and the voltage rating of the motor. It is not saved and is recalculated when any of the parameters affecting its value are changed. The normal range for this parameter is 0.40 to 0.60 pu. A warning will be displayed if this parameter is outside the range of 0.25 to 0.75 pu.

Magnetizing Inductance Measured [L magn measured]

Linear number: 134
Minimum value: 1.00 pu
Maximum value: 15.00 pu
Default value: N/A

This parameter represents the motor magnetizing inductance measured by the drive control. It is obtained by dividing the measured flux feedback by the magnetizing current. This parameter is not saved and is continuously recalculated.

Lmd [Lmd]

Linear number: 135
Minimum value: 0.00 pu
Maximum value: 10.00 pu
Default value: 1.00 pu

This parameter specifies the d-axis magnetizing inductance for synchronous motors. It can be set manually or by autotuning. This parameter is not used for induction motors.

[This parameter was added in Rev 5.10 and is not present in 4.xx.](#)

10 Converter Parameters

Series Thyristor Line [Series thy line]

Linear number: 145
Minimum value: 1
Maximum value: 6
Default value: 1

This parameter specifies the number of series thyristors in each of the 6 legs of the line converter.

Series Thyristor Motor [Series thy motor]

Linear number: 146
Minimum value: 1
Maximum value: 6
Default value: 1

This parameter specifies the number of series GTO thyristors in each of the 6 legs of the machine converter.

Redundant Thyristor Line [Redundt thy line]

Linear number: 147
Minimum value: 0
Maximum value: 1
Default value: 0

This parameter specifies the number of redundant thyristors in each of the 6 legs of the line converter.

Redundant Thyristor Motor [Redundt thy mtr]

Linear number: 148
Minimum value: 0
Maximum value: 1
Default value: 0

This parameter specifies the number of redundant GTO thyristors in each of the 6 legs of the machine converter.

CT Ratio Line [CT ratio line]

Linear number: 149
Minimum value: 10
Maximum value: 10000
Default value: 200

This parameter specifies the ratio of the current transformers used for line current feedback.

CT Ratio Motor [CT ratio motor]

Linear number: 150
Minimum value: 10
Maximum value: 10000
Default value: 2500

This parameter specifies the ratio of the current transducers (LEMs) used for motor current feedback.

CT Burden Line [CT burden line]

Linear number: 151
 Minimum value: 1.0 ohms
 Maximum value: 1000.0 ohms (FRN 5.xx) 6300.0 ohms (FRN 4.xx)
 Default value: 15.0 ohms

This parameter specifies the value of the scaling resistors for the line current feedback.

To determine the required value for the scaling resistors, first calculate the equivalent scaling resistance using the following formula:

$$R = \frac{1.768V_{CT} \cdot Ratio}{RatedMotorAmps} \text{ ohms}$$

Because of hardware differences between the original Drive Control board and the new 18-pulse Drive Control board, the actual value of resistor required depends on the firmware version:

For firmware revisions less than 5.00:

$$C.T. \text{ burden line} = \frac{249 \times R}{249 - R} \text{ ohms}$$

For firmware revisions of 5.00 and above:

$$C.T. \text{ burden line} = R \times \frac{6}{PulseNumber} \text{ ohms}$$

Select the nearest standard resistor value.

CT Burden Motor [CT burden motor]

Linear number: 152
 Minimum value: 1.0 ohms
 Maximum value: 1000.0 ohms (FRN 5.10) 6300.0 ohms (FRN 4.xx)
 Default value: 39.0 ohms

This parameter specifies the value of the scaling resistors for the motor current feedback.

To determine the required value for the scaling resistors, first calculate the equivalent scaling resistance using the following formula:

$$R = \frac{1.768V_{LEM} \cdot Ratio}{RatedMotorAmps} \text{ ohms}$$

Because of hardware differences between the original Drive Control board and the new 18-pulse Drive Control board, the actual value of resistor required depends on the firmware version:

For firmware revisions less than 5.00:

$$C.T. \text{ burden motor} = \frac{249 \times R}{249 - R} \text{ ohms}$$

For firmware revisions of 5.00 and above:

$$CT \text{ burden motor} = R \text{ ohms}$$

Select the nearest standard resistor value.

Pulse Number [Pulse number]

Linear number: 153
Minimum value: 6
Maximum value: 18 (FRN5.xx) 12 (FRN4.xx)
Default value: 6

This parameter specifies the pulse number (6, 12, or 18) of the line converter. If this parameter is changed, the control power must be turned off and on before the new value takes effect.

Warning: Setting this parameter to the wrong value may cause multiple failures of line converter thyristors.

CT Configuration [CT configuration]

Linear number: 154
Minimum value: 2
Maximum value: 3
Default value: 2

This parameter specifies the number of current transformers per bridge for 12-pulse drives. Set this parameter to 2 for drives with 2 CT's on the master bridge only, and to 3 for drives with 3 CT's on both the master and slave bridges. If the wrong value is entered for this parameter, the line current feedback scaling will be wrong.

This parameter was added in Rev 4.72 and is not present in 5.xx

PWM Frequency Maximum [PWM freq maximum]

Linear number: 155
Minimum value: 200 Hz
Maximum value: 280 Hz or 560 Hz (FRN 5.30)
Default value: 200 Hz

This parameter specifies the maximum GTO switching frequency. All PWM mode transition frequencies are proportional to this parameter. The 560 Hz maximum applies to Powerflex drives only. Bulletin 1557 drives rated less than 4000V and 2000 KW are automatically limited to 225 Hz maximum.

Flux Minimum [Flux minimum]

Linear number: 156
Minimum value: 0.20 pu
Maximum value: 2.00 pu
Default value: 0.40 pu

This parameter specifies the minimum flux level for operation in the normal running mode. It is normally set to 0.40 pu.

CT Ratio Ground Fault [CT ratio gnd flt]

Linear number: 157
Minimum value: 10
Maximum value: 10000
Default value: 2000

This parameter specifies the ratio of the current transformer used to measure the ground fault (zero sequence) current at the input of the drive.

NOTE: When upgrading the firmware from a revision prior to 3.40, the bridge rectifier on the secondary of the ground fault CT should be removed, but the burden resistor and zener diodes should be retained unchanged.

CT Burden Ground Fault [CT burden gndflt]

Linear number: 158
Minimum value: 10 ohms
Maximum value: 10000 ohms
Default value: 1000 ohms

This parameter specifies the value of the scaling resistor used for the ground fault current feedback.

Current Feedback Rated Line [I fbk rated line]

Linear number: 159
Minimum value: 0.500 V
Maximum value: 2.500 V
Default value: N/A

This parameter specifies the rated line current feedback in volts rms calculated from the line CT ratio and burden and the rated motor current. It is not saved and is recalculated when any of the parameters affecting its value are changed. The nominal value is 1.768 V. A warning will be displayed if this parameter is out of range.

Current Feedback Rated Motor [I fbk rated motor]

Linear number: 160
Minimum value: 0.500 V
Maximum value: 2.500 V
Default value: N/A

This parameter specifies the rated motor current feedback in volts rms calculated from the motor CT ratio and burden and the rated motor current. It is not saved and is recalculated when any of the parameters affecting its value are changed. The nominal value is 1.768 V. A warning will be displayed if this parameter is out of range.

11 Line Converter Protection Parameters**Line Overcurrent Trip [Line O/C trip]**

Linear number: 161
Minimum value: 0.00 pu
Maximum value: 2.00 pu
Default value: 1.50 pu

This parameter specifies the level the line current must exceed before a line overcurrent fault is indicated.

NOTE: For current ratings near the maximum for the drive frame size, this parameter will be automatically limited to a maximum value less than 2.00. This feature was added in Rev 4.62/5.11.

Line Overcurrent Delay [Line O/C delay]

Linear number: 162
Minimum value: 0.000 sec
Maximum value: 0.040 sec
Default value: 0.004 sec

This parameter specifies the time the line current must remain above the trip level before a line overcurrent fault is indicated.

Line Overload Trip [Line O/L trip]

Linear number: 163
Minimum value: 0.20 pu
Maximum value: 1.15 pu
Default value: 1.00 pu

This parameter specifies the maximum continuous operating current of the drive.

Line Overload Delay [Line O/L delay]

Linear number: 164
Minimum value: 0 sec
Maximum value: 61 sec
Default value: 60 sec

This parameter specifies the time the drive may operate at 1.5 times the overload trip level before a line converter overload fault is indicated.

Line Overvoltage Trip [Line O/V trip]

Linear number: 165
Minimum value: 0.00 pu
Maximum value: 1.50 pu
Default value: 1.20 pu

This parameter specifies the level the line voltage must exceed before a line overvoltage fault is indicated.

Line Overvoltage Delay [Line O/V delay]

Linear number: 166
Minimum value: 0.000 sec
Maximum value: 10.000 sec
Default value: 0.050 sec

This parameter specifies the time the line voltage must remain above the trip level before a line overvoltage fault is indicated.

Line Undervoltage Trip [Line U/V trip]

Linear number: 167
Minimum value: 0.70 pu
Maximum value: 1.50 pu
Default value: 0.85 pu

This parameter specifies the level the line voltage must fall below before a line undervoltage condition is indicated.

Line Undervoltage Delay [Line U/V delay]

Linear number: 168
Minimum value: 0.010 sec
Maximum value: 0.040 sec
Default value: 0.020 sec

This parameter specifies the time the line voltage must remain below the trip level before a line undervoltage condition is indicated.

DC Link Overcurrent Trip [DC O/C trip]

Linear number: 169
Minimum value: 0.10 pu
Maximum value: 2.00 pu
Default value: 2.00 pu

This parameter specifies the level the dc link current must exceed before a dc link overcurrent fault is indicated.

NOTE: For current ratings near the maximum for the drive frame size, this parameter will be automatically limited to a maximum value less than 2.00. This feature was added in Rev 4.60/5.10.

DC Link Overcurrent Delay [DC O/C delay]

Linear number: 170
Minimum value: 0.000 sec
Maximum value: 0.040 sec
Default value: 0.004 sec

This parameter specifies the time the dc link current must remain above the trip level before a dc link overcurrent fault is indicated.

NOTE: For Bulletin 1557M Drives, this parameter is internally limited to 0.004 sec maximum.

Ground Fault Overcurrent Trip [Gnd flt O/C trip]

Linear number: 171
Minimum value: 0.0 A
Maximum value: 1.0 A
Default value: 0.5 A

This parameter specifies the level the ground fault current signal must exceed before a ground fault overcurrent is indicated.

Ground Fault Overcurrent Delay [Gnd flt O/C dly]

Linear number: 172
Minimum value: 0.000 sec
Maximum value: 1.000 sec
Default value: 0.050 sec

This parameter specifies the time the ground fault current signal must remain above the trip level before a ground fault overcurrent is indicated.

Line dc link Over Voltage Trip [Line DC O/V trip]

Linear number: 173
Minimum value: 0.10 pu
Maximum value: 1.47 pu
Default value: 1.47 pu

This parameter specifies the level the line side dc link voltage must exceed before a dc link over voltage fault is indicated.

[This parameter was added in Rev 4.55/5.10.](#)

Line dc link Over Voltage Delay [Line DC O/V dly]

Linear number: 174
Minimum value: 0.00 sec
Maximum value: 0.040 sec
Default value: 0.010 sec

This parameter specifies the time the line side dc link voltage must remain above the trip level before a dc link over voltage fault is indicated.

[This parameter was added in Rev 4.55/5.10.](#)

Fan Loss Trip [Fan loss trip]

Linear number: 175
Minimum value: 0.0 V
Maximum value: 9.9 V
Default value: 2.0 V

This parameter specifies the level that the output of the static pressure sensor in the converter cubicle must fall to before a fan loss warning is indicated. If the pressure falls below 80% of the trip level, a fan loss fault will be indicated and the drive will stop. This parameter is used for Powerflex drives only, because 1557 drives do not have a pressure sensor.

[This parameter was added in Rev 5.30 and is not present in 4.xx.](#)

Fan Loss Delay [Fan loss delay]

Linear number: 176
Minimum value: 0.0 sec
Maximum value: 60.0 sec
Default value: 5.0 sec

This parameter specifies the time the static pressure in the converter cubicle must remain below the trip level before a fan loss warning or fault is indicated. The delay must be longer than the starting time of the cooling fan.

[This parameter was added in Rev 5.30 and is not present in 4.xx.](#)

12 Motor Converter Protection Parameters**Motor Overcurrent Trip [Motor O/C trip]**

Linear number: 177
Minimum value: 0.00 pu
Maximum value: 2.00 pu
Default value: 1.50 pu

This parameter specifies the level the motor current must exceed before a motor overcurrent fault is indicated.

Motor Overcurrent Delay [Motor O/C delay]

Linear number: 178
Minimum value: 0.000 sec
Maximum value: 0.100 sec
Default value: 0.020 sec

This parameter specifies the time the motor current must remain above the trip level before a motor overcurrent fault is indicated.

Motor Overload Trip [Motor O/L trip]

Linear number: 179
Minimum value: 0.20 pu
Maximum value: 1.15 pu
Default value: 1.00 pu

This parameter specifies the maximum continuous operating current of the motor.

Motor Overload Delay [Motor O/L delay]

Linear number: 180
Minimum value: 0 sec
Maximum value: 61 sec
Default value: 60 sec

This parameter specifies the time the motor may operate at 1.5 times the overload trip level before a motor converter overload fault is indicated.

Motor Overvoltage Trip [Motor O/V trip]

Linear number: 181
Minimum value: 0.00 pu
Maximum value: 1.50 pu
Default value: 1.20 pu

This parameter specifies the level the motor voltage must exceed before a motor overvoltage fault is indicated.

Motor Over Voltage Delay [Motor O/V delay]

Linear number: 182
Minimum value: 0.000 sec
Maximum value: 10.000 sec
Default value: 0.050 sec

This parameter specifies the time the motor voltage must remain above the trip level before a motor over voltage fault is indicated.

Motor Unbalance Trip [Motor U/B trip]

Linear number: 183
Minimum value: 0.00 pu
Maximum value: 1.00 pu
Default value: 0.10 pu

This parameter specifies the level the motor current unbalance must exceed before a motor unbalance fault is indicated.

This parameter was added in Rev 5.30 and is not present in 4.xx.

Motor Unbalance Delay [Motor U/B delay]

Linear number: 184
Minimum value: 0.00 sec
Maximum value: 10.00 sec
Default value: 2.00 sec

This parameter specifies the time the motor current unbalance must remain above the trip level before a motor unbalance fault is indicated.

This parameter was added in Rev 5.30 and is not present in 4.xx.

Motor Over Speed Trip [Over speed trip]

Linear number: 185
Minimum value: 10 Hz
Maximum value: 100 Hz
Default value: 66 Hz

This parameter specifies the level the motor speed must exceed before a motor overspeed fault is indicated.

Motor Overspeed Delay [Overspeed delay]

Linear number: 186
Minimum value: 0.00 sec
Maximum value: 10.00 sec
Default value: 0.50 sec

This parameter specifies the time the motor speed must exceed the trip level before a motor overspeed fault is indicated.

Motor DC Link Over Voltage Trip [Mtr DC O/V trip]

Linear number: 187
Minimum value: 0.10 pu
Maximum value: 1.47 pu
Default value: 1.47 pu

This parameter specifies the level the machine side dc link voltage must exceed before a dc link over voltage fault is indicated.

DC Link Overvoltage Delay [DC O/V delay]

Linear number: 188
Minimum value: 0.000 sec
Maximum value: 0.040 sec
Default value: 0.004 sec

This parameter specifies the time the machine side dc link voltage must remain above the trip level before a dc link overvoltage fault is indicated.

Note: For Bulletin 1557M drives this parameter is internally limited to 0.004 sec maximum.

Ground Fault Overvoltage Trip [Gnd flt O/V trip]

Linear number: 189
Minimum value: 0.00 pu
Maximum value: 1.50 pu
Default value: 0.20 pu

This parameter specifies the level the motor neutral to ground voltage must exceed before a ground fault overvoltage is indicated.

Note: The value of this parameter must be increased for drives without isolation transformers because the neutral to ground voltage will be quite high in normal operation.

Ground Fault Overvoltage Delay [Gnd flt O/V dly]

Linear number: 190
Minimum value: 0.000 sec
Maximum value: 5.000 sec
Default value: 0.500 sec

This parameter specifies the time the motor neutral to ground voltage must remain above the trip level before a ground fault overvoltage is indicated.

Motor Stall Delay [Mtr stall delay]

Linear number: 191
Minimum value: 0.00 sec
Maximum value: 10.0 sec
Default value: 2.00 sec

This parameter specifies the time the motor must be in a stall condition before a motor stall fault occurs. If the tachometer option is enabled, the motor is considered to be stalled if the drive is in torque limit at any speed less than 1 Hz. If the tachometer option is not enabled, the motor is considered to be stalled if the drive is at commanded speed and the motor flux is below the level specified by parameter "Flux minimum". A stall cannot be detected until the drive reaches the commanded speed because the motor may already be rotating when the drive is started. In this case, if the motor speed is above the commanded speed, or the motor is rotating in the opposite direction, a stall fault will occur.

V Stator Minimum Thyristor Fault [Vs min thy fault]

Linear number: 192
Minimum value: 0.10 pu
Maximum value: 0.50 pu
Default value: 0.25 pu

This parameter specifies the minimum stator voltage required for detection of machine converter thyristor faults. If the drive is incorrectly detecting motor thyristor faults while running (not while starting), increasing this parameter may eliminate the problem.

[This parameter was added in Rev 5.10 and is not present in 4.xx.](#)

13 Analog Output Parameters**Analog Offset 4L [Analog offset 4L]**

Linear number: 201
Minimum value: -10.00 V
Maximum value: 9.92 V
Default value: 0.00 V

This parameter specifies the offset voltage for analog output 4L.

[This parameter was added in Rev 5.00 and is not present in 4.xx.](#)

Analog Offset 5L [Analog offset 5L]

Linear number: 193
Minimum value: -10.00 V
Maximum value: 9.92 V
Default value: 0.00 V

This parameter specifies the offset voltage for analog output 5L.

Analog Offset 6L [Analog offset 6L]

Linear number: 194
Minimum value: -10.00 V
Maximum value: 9.92 V
Default value: 0.00 V

This parameter specifies the offset voltage for analog output 6L.

Analog Offset 4M [Analog offset 4M]

Linear number: 202
Minimum value: -10.00 V
Maximum value: 9.92 V
Default value: 0.00 V

This parameter specifies the offset voltage for analog output 4M.

[This parameter was added in Rev 5.00 and is not present in 4.xx.](#)

Analog Offset 5M [Analog offset 5M]

Linear number: 195
Minimum value: -10.00 V
Maximum value: 9.92 V
Default value: 0.00 V

This parameter specifies the offset voltage for analog output 5M.

Analog Offset 6M [Analog offset 6M]

Linear number: 196
Minimum value: -10.00 V
Maximum value: 9.92 V
Default value: 0.00V

This parameter specifies the offset voltage for analog output 6M.

Analog Scale 4L [Analog scale 4L]

Linear number: 203
Minimum value: 0.000
Maximum value: 10.000
Default value: 1.000

This parameter specifies the multiplication scale factor for analog output 4L.

[This parameter was added in Rev 5.00 and is not present in 4.xx.](#)

Analog Scale 5L [Analog scale 5L]

Linear number: 197
 Minimum value: 0.000
 Maximum value: 10.000
 Default value: 1.000

This parameter specifies the multiplication scale factor for analog output 5L. If this output is used to drive an analog voltmeter, the scale factor can be calculated using the following formula:

$$\text{Analog Scale 5L} = \frac{4096V}{\text{meter.reading.at.10.Volts}}$$

Analog Scale 6L [Analog scale 6L]

Linear number: 198
 Minimum value: 0.000
 Maximum value: 10.000
 Default value: 1.000

This parameter specifies the multiplication scale factor for analog output 6L. If this output is used to drive an analog ammeter, the scale factor can be calculated using the following formula:

$$\text{Analog Scale 6L} = \frac{128A}{\text{meter.reading.at.10.Volts}}$$

Analog Scale 4M [Analog scale 4M]

Linear number: 204
 Minimum value: 0.000
 Maximum value: 10.000
 Default value: 1.000

This parameter specifies the multiplication scale factor for analog output 4M.

[This parameter was added in Rev 5.00 and is not present in 4.xx.](#)

Analog Scale 5M [Analog scale 5M]

Linear number: 199
 Minimum value: 0.000
 Maximum value: 10.000
 Default value: 1.000

This parameter specifies the multiplication scale factor for analog output 5M. If this output is used to drive an analog speed meter, the scale factor can be calculated using the following formula:

$$\text{Analog Scale 5M} = \frac{4096RPM}{\text{meter.reading.at.10.Volts}}$$

Analog Scale 6M [Analog scale 6M]

Linear number: 200
 Minimum value: 0.000
 Maximum value: 10.000
 Default value: 1.000

This parameter specifies the multiplication scale factor for analog output 6M. If this output is used to drive an analog power meter, the scale factor can be calculated using the following formula:

$$\text{Analog Scale 6M} = \frac{4096KW}{\text{meter.reading.at.10.Volts}}$$

14 External Fault Parameters

A total of sixteen external fault inputs are provided. All sixteen can be sent from an external device via Remote I/O. Any of the first eight external faults can use discrete hardware inputs instead. The first three hardware fault inputs are standard and the remaining five require the optional discrete I/O. The class of each of the external faults is specified by a corresponding parameter. Class 1 faults cause the drive to trip immediately. Class 2 faults cause the drive to decelerate to a stop at the normal ramp rate before tripping. Class 3 faults are merely warnings and cause no action to be taken. External fault messages are displayed on the terminal in the same way as the permanent internal faults. The text of the external fault messages can be changed through the terminal.

External Fault 1-16 Class [Ext flt 1-16 class]

Linear numbers: 209-224
 Minimum value: 1
 Maximum value: 3
 Default value: 2

These 16 parameters specify the class of each of the external faults.

[These parameters were deleted in Rev 4.10 and reinstated in Rev 4.55/5.00.](#)

15 Autotune Parameters

Autotune Select [Autotune Select]

Linear number: 12
 Minimum value: 0
 Maximum value: 8
 Default value: 0

This parameter specifies the autotuning function to be performed:

- 0 Autotuning off
- 1 Commutation inductance
- 2 DC link time constant
- 3 Commutation inductance and DC link time constant (1 & 2)
- 4 Motor stator resistance
- 5 Motor leakage inductance
- 6 Flux regulator
- 7 Total inertia
- 8 Flux regulator and total inertia (6 & 7)

The value of this parameter is set to zero after completion of the selected function.

Autotune Idc Command [Autotune Idc cmd]

Linear number: 124
 Minimum value: 0.100 pu
 Maximum value: 0.900 pu
 Default value: 0.500 pu

This parameter specifies the dc current command used during autotuning of the dc link time constant. If the value of this parameter is set too low, the dc link current may become discontinuous and the autotuning may produce invalid results.

Autotune Idc Step [Autotune Idc stp]

Linear number: 125
 Minimum value: 0.000 pu
 Maximum value: 0.500 pu
 Default value: 0.250 pu

This parameter specifies the value of the step that is added to the dc current command during autotuning of the dc link time constant. If the value of this parameter is set too high relative to the dc current command, the dc link current may become discontinuous and the autotuning may produce invalid results.

Autotune Idc Bandwidth [Autotune ldc BW]

Linear number: 126
Minimum value: 10 r/s
Maximum value: 100 r/s
Default value: 50 r/s

This parameter specifies the bandwidth of the current regulator during autotuning of the dc link time constant. A lower bandwidth is used during autotuning than during normal operation because a slower response can be measured more accurately.

Autotune Speed Command [Autotune spd cmd]

Linear number: 94
Minimum value: 20.0 Hz
Maximum value: 50.0 Hz
Default value: 30.0 Hz

This parameter specifies the speed command used during autotuning of the flux regulator and total inertia.

Prior to Rev 4.72/5.20, this parameter was called Autotune Speed Command Minimum and was defined differently.

Autotune Torque Step [Autotune trq stp]

Linear number: 96
Minimum value: 0.050
Maximum value: 0.500
Default value: 0.100

This parameter specifies the size of the torque step that is added to the torque command during autotuning of the total inertia. A value of 1.000 corresponds to rated torque.

Prior to Rev 4.60/5.00, this parameter was scaled in per unit based on the motor rated kVA and was about 10% lower.

Autotune Isd Step [Autotune Isd step]

Linear number: 107
Minimum value: 0.001 pu
Maximum value: 0.020 pu
Default value: 0.010 pu

This parameter specifies the size of the step that is added to the magnetizing current command during autotuning of the flux regulator for synchronous machines. It is not used for induction motors.

This parameter was added in Rev 5.00 and is not present in 4.xx.

Autotune Commutation Inductance [Autotune Lc]

Linear number: 127
Minimum value: 0.00 pu
Maximum value: 0.50 pu
Default value: 0.00 pu

This parameter specifies the value of commutation inductance determined during autotuning. If the commutation inductance autotuning is successful, then parameter "L commutation" in "P Current Control" is set equal to the value of this parameter. If the commutation inductance autotuning fails, then parameter "L commutation" is not changed.

Autotune dc Link Time Constant [Autotune Tdc]

Linear number: 128
 Minimum value: 0.000 sec
 Maximum value: 0.160 sec
 Default value: 0.000 sec

This parameter specifies the value of dc link time constant determined during autotuning. If the dc link time constant measurement is successful, then parameter "T dc link" in "P Current Control" is set equal to the value of this parameter. If the dc link time constant measurement fails, then parameter "T dc link" is not changed.

Autotune Stator Resistance [Autotune Rs]

Linear number: 140
 Minimum value: 0.00 pu
 Maximum value: 0.20 pu
 Default value: 0.00 pu

This parameter specifies the value of motor stator resistance determined during autotuning. If the stator resistance autotuning is successful, then parameter " R Stator " in " P Motor model" is set equal to the value of this parameter. If the stator resistance autotuning fails, then parameter " R stator" is not changed.

Autotune Leakage Inductance [Autotune Ls]

Linear number: 141
 Minimum value: 0.00 pu
 Maximum value: 0.74 pu
 Default value: 0.00 pu

This parameter specifies the value of motor leakage inductance determined during autotuning. If the leakage inductance autotuning is successful, then parameter "L total leakage" in "P Motor Model" is set equal to the value of this parameter. If the leakage inductance autotuning fails, then parameter "L total leakage" is not changed.

Autotune Magnetizing Inductance [Autotune Lm]

Linear number: 142
 Minimum value: 0.00 pu
 Maximum value: 15.00 pu
 Default value: 0.00 pu

This parameter specifies the value of motor magnetizing inductance determined during flux regulator autotuning. If the magnetizing inductance measurement is successful, then parameter "L magnetizing" in "P Motor Model" is set equal to the value of this parameter. If the magnetizing inductance measurement fails, then parameter "L magnetizing" is not changed.

Autotune Rotor Time Constant [Autotune T rotor]

Linear number: 143
 Minimum value: 0.00 sec
 Maximum value: 10.00 sec
 Default value: 0.00 sec

This parameter specifies the value of rotor time constant determined during flux regulator autotuning. If the rotor time constant measurement is successful, then parameter "T rotor" in "P Motor Model" is set equal to the value of this parameter. If the rotor time constant measurement fails, then parameter "T rotor" is not changed.

Autotune Lmd [Autotune Lmd]

Linear number: 139
 Minimum value: 0.00 pu
 Maximum value: 10.00 pu
 Default value: 0.00 pu

This parameter specifies the value of d-axis magnetizing inductance for synchronous machines determined during flux regulator autotuning. If the magnetizing inductance measurement is successful, then parameter "Lmd" in "P Motor Model" is set equal to the value of this parameter. If the magnetizing inductance measurement fails, then parameter "Lmd " is not changed. This parameter is not used for induction motors

[This parameter was added in Rev 5.10 and is not present in 4.xx.](#)

Autotune Inertia [Autotune inertia]

Linear number: 144
Minimum value: 0.00 sec
Maximum value: 100.00 sec
Default value: 0.00 sec

This parameter specifies the value of total system inertia measured during autotuning. If the inertia measurement is successful, then parameter "Total inertia" in "P Speed Control" is set equal to the value of this parameter. If the inertia measurement fails, then parameter "Total inertia" is not changed.

16 Option Parameters**Synchronizing Regulator Gain [Sync reg gain]**

Linear number: 225
Minimum value: 0.0
Maximum value: 7.9
Default value: 1.0

This parameter specifies the gain of the synchronizing regulator.

Synchronous Transfer Lead Angle [Sync lead angle]

Linear number: 226
Minimum value: -90 degrees
Maximum value: 90 degrees
Default value: 0 degrees

This parameter specifies the angle by which the motor voltage leads the drive input voltage when the motor is assumed to be synchronized. The purpose of this parameter is to compensate for any phase difference between the drive input voltage and the bypass contactor supply voltage.

Synchronous Transfer Off Delay [Sync off delay]

Linear number: 227
Minimum value: 0.000 seconds
Maximum value: 0.500 seconds
Default value: 0.100 seconds

This parameter specifies the time delay between the bypass contactor being requested to close and the drive shutting off. It is normally set to slightly less than the contactor closing time.

Synchronizing Error Maximum [Sync error max]

Linear number: 228
Minimum value: 0 degrees
Maximum value: 30 degrees
Default value: 0 degrees

This parameter specifies the maximum allowable synchronizing phase error. The bypass contactor will be requested to close when the synchronizing phase error has remained below this maximum value for the time specified by the Synchronizing Time parameter.

Synchronizing Time [Sync time]

Linear number: 229
Minimum value: 0.1 seconds
Maximum value: 10.0 seconds
Default value: 1.0 seconds

This parameter specifies the time that the synchronizing phase error must be less than Synchronizing Error Maximum before the bypass contactor is requested to close.

Synchronous Transfer Time [Sync xfer time]

Linear number: 230
 Minimum value: 0.1 min.
 Maximum value: 57.0 min.
 Default value: 1.0 min.

This parameter specifies the time allowed for completion of a synchronous transfer. If transfer is not complete within this time, the drive will stop with a “sync transfer failed” fault. If the “sync transfer failed” fault is disabled, the transfer request will be cancelled and the drive will continue to run at the commanded speed. A “sync transfer failed” warning will be displayed.

[This parameter was added in Rev 4.60/5.10.](#)

External Fault Input [Ext fault input]

Linear number: 232
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Default value: 0000 Hex

This parameter specifies the external fault inputs. It is bit encoded as shown below:

xxx1H - External Fault 1
 xxx2H - External Fault 2
 xxx4H - External Fault 3
 xxx8H - External Fault 4
 xx1xH - External Fault 5
 xx2xH - External Fault 6
 xx4xH - External Fault 7
 xx8xH - External Fault 8
 x1xxH - External Fault 9
 x2xxH - External Fault 10
 x4xxH - External Fault 11
 x8xxH - External Fault 12
 1xxxH - External Fault 13
 2xxxH - External Fault 14
 4xxxH - External Fault 15
 8xxxH - External Fault 16

The presence of an external fault is indicated by setting the corresponding bit. The absence of an external fault is indicated by clearing the corresponding bit.

This parameter is normally sent from an external device via RI/O. The first eight external faults are OR'ed with the eight hardware fault inputs (i.e. the maximum number of external faults is 16, not 24). If any of the first eight external faults are sent from an external device via RI/O, the corresponding hardware fault input must not be connected.

Tachometer Type [Tach type]

Linear number: 233
 Minimum value: 1
 Maximum value: 2 or 3 (FRN5.20 only)
 Default value: 2

This parameter specifies the type of tachometer or encoder installed.

- 1 single output (non-directional)
- 2 quadrature outputs (directional)
- 3 absolute encoder (for synchronous machines)

Warning: If tachometer type is set to 1, the drive cannot determine the direction of rotation when the motor is coasting. If the direction of rotation is not the same as the commanded direction, a flying start will not be successful.

Tachometer Pulses Per Revolution [Tach pulse/rev]

Linear number: 234
Minimum value: 120
Maximum value: 4096
Default value: 360

This parameter specifies the number of pulses produced by the tachometer in one revolution. This parameter is not used for absolute encoders.

Tachometer Loss Trip [Tach loss trip]

Linear number: 235
Minimum value: 0.0 Hz
Maximum value: 10.0 Hz
Default value: 2.0 Hz

This parameter specifies the amount by which the speed feedback from the tachometer and the speed feedback derived from stator frequency must differ before a tachometer loss fault is indicated.

Tachometer Loss Delay [Tach loss delay]

Linear number: 236
Minimum value: 0.00 sec
Maximum value: 1.00 sec
Default value: 0.10 sec

This parameter specifies the time that the tachometer error must be greater than the trip level before a tachometer loss fault is indicated.

Tachometer Select [Tach select]

Linear number: 237
Minimum value: 0
Maximum value: 3
Default value: 0

This parameter specifies which of the four tachometer inputs available on the Tachometer Feedback Board is to be used by the drive. It is not used for synchronous motors with absolute encoders.

Encoder Offset [Encoder offset]

Linear number: 238
Minimum value: 0 deg
Maximum value: 359 deg
Default value: 0 deg

This parameter specifies the value of the offset between the rotor d-axis of the synchronous machine and the zero of the absolute position encoder. It can be set manually or by autotuning. This parameter is not used for induction motors with incremental encoders.

Warning: Parameter "Speed Feedback Select" should not be set to 1 until the encoder offset has been correctly set.

[This parameter was added in Rev 5.20 and is not present in 4.xx.](#)

Encoder Reverse [Encoder reverse]

Linear number: 239
 Minimum value: 0
 Maximum value: 1
 Default value: 0

This parameter specifies the direction of rotation of an absolute position encoder. If the parameter is set to 1, the drive firmware reverses the output of the encoder. The encoder rotation should be reversed if a "Tach rotation" warning occurs and cannot be cleared when the drive is running (the warning can always be cleared when the drive is stopped). This parameter is not used for induction motors with incremental encoders.

Warning: Parameter "Speed Feedback Select" should not be set to 1 until the encoder direction has been correctly set.

This parameter was added in Rev 5.20 and is not present in 4.xx.

17 Control Mask Parameters

The parameters in this group specify which adapters are allowed to control the various drive functions. All the parameters in this group are bit encoded as shown below:

xxx1H - adapter 0
 xxx2H - adapter 1
 xxx4H - adapter 2
 xxx8H - adapter 3
 xx1xH - adapter 4
 xx2xH - adapter 5
 xx4xH - adapter 6
 xx8xH - adapter 7

Setting a bit enables the function for the corresponding adapter. Clearing a bit disables the function for the corresponding adapter. There is no mask for the stop function because it is enabled for all connected adapters at all times. The control mask parameters are not saved and are set to their default value at power up.

Logic Mask [Logic mask]

Linear number: 241
 Minimum value: 00 Hex
 Maximum value: FF Hex
 Default value: FF Hex

This parameter specifies which adapters can issue commands to the drive.

Local Mask [Local mask]

Linear number: 242
 Minimum value: 00 Hex
 Maximum value: FF Hex
 Default value: FF Hex

This parameter specifies which adapters can take exclusive local control of the drive.

Start Mask [Start mask]

Linear number: 243
 Minimum value: 00 Hex
 Maximum value: FF Hex
 Default value: FF Hex

This parameter specifies which adapters can issue start commands.

Direction Mask [Direction mask]

Linear number: 244
Minimum value: 00 Hex
Maximum value: FF Hex
Default value: FF Hex

This parameter specifies which adapters can issue forward/reverse commands.

Jog Mask [Jog mask]

Linear number: 245
Minimum value: 00 Hex
Maximum value: FF Hex
Default value: FF Hex

This parameter specifies which adapters can issue jog commands.

Fault Reset Mask [Reset mask]

Linear number: 247
Minimum value: 00 Hex
Maximum value: FF Hex
Default value: FF Hex

This parameter specifies which adapters can issue fault reset commands.

Speed Command Mask [speed cmd mask]

Linear number: 248
Minimum value: 00 Hex
Maximum value: FF Hex
Default value: FF Hex

This parameter specifies which adapters can select the drive speed command.

Synchronous Transfer Mask [Sync xfer mask]

Linear number: 249
Minimum value: 00 Hex
Maximum value: FF Hex
Default value: FF Hex

This parameter specifies which adapters can issue synchronous transfer commands.

Variable Descriptions

The drive variables are described in this section. The variable descriptions are arranged in the functional groups used by the programming terminal. Each description begins with the full name of the variable, followed by the name displayed on the programming terminal. The linear number of the variable is given followed by the minimum and maximum values showing the position of the decimal point and the units if applicable. Next is the scaling which applies when the variable is assigned to an analog output. Finally, there is a short description of the function of the variable.

18 Status Variables

Logic Command [Logic command]

Linear number: 257
 Minimum value: 0000 Hex
 Maximum Value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the value of the logic command word. It is bit encoded as shown below:

xxx1H - not stop
 xxx2H - start
 xxx4H - reverse
 xxx8H - jog

xx1xH - increase speed command
 xx2xH - decrease speed command
 xx4xH - reset faults & warnings
 xx8xH - clear fault & warning queue

x1xxH - transfer to drive
 x2xxH - transfer to bypass
 x4xxH - not defined
 x8xxH - not defined

0xxxH - select external speed command 0 (analog input 1L)
 1xxxH - select preset speed command 1
 2xxxH - select preset speed command 2
 3xxxH - select preset speed command 3
 4xxxH - select preset speed command 3
 5xxxH - select preset speed command 3
 6xxxH - select preset speed command 3
 7xxxH - select preset speed command 3
 8xxxH - select external speed command 8 (analog input 1M)
 9xxxH - select port 1 speed command
 AxxxH - select port 2 speed command
 BxxxH - select port 3 speed command
 CxxxH - select port 4 speed command
 DxxxH - select port 5 speed command
 ExxxH - select port 6 speed command
 FxxxH - select preset jog speed command

Logic Status 1 [Logic status 1]

Linear number: 258
Minimum value: 0000 Hex
Maximum Value: FFFF Hex
Analog Output Scaling: NA

This variable is the value of logic status 1, the status word that has the same definition for all drives. It is bit encoded as shown below:

xxx1H - enabled
xxx2H - running
xxx4H - forward command
xxx8H - forward rotation

xx1xH - accelerating
xx2xH - decelerating
xx4xH - warning
xx8xH - fault

x1xxH - at speed command
x0xxH - port 0 local
x2xxH - port 1 local
x4xxH - port 2 local
x6xxH - port 3 local
x8xxH - port 4 local
xAxxH - port 5 local
xCxxH - port 6 local
xExxH - no local

0xxxH - external speed command 0 selected (analog input 1L)
1xxxH - preset speed command 1 selected
2xxxH - preset speed command 2 selected
3xxxH - preset speed command 3 selected
4xxxH - preset speed command 3 selected
5xxxH - preset speed command 3 selected
6xxxH - preset speed command 3 selected
7xxxH - preset speed command 3 selected
8xxxH - external speed command 8 selected (analog input 1M)
9xxxH - port 1 speed command selected
AxxxH - port 2 speed command selected
BxxxH - port 3 speed command selected
CxxxH - port 4 speed command selected
DxxxH - port 5 speed command selected
ExxxH - port 6 speed command selected
FxxxH - preset jog speed command selected

Local Discrete Inputs [Local inputs]

Linear number: 260
 Minimum value: 0000 Hex
 Maximum Value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the value of the 16 local discrete digital inputs. It is bit encoded as shown below:

xxx1H - not stop
 xxx2H - start
 xxx4H - input contactor closed
 xxx8H - output contactor closed
 xx1xH - select speed command 8
 xx2xH - not external fault 1
 xx4xH - not external fault 2
 xx8xH - not external fault 3

 x1xxH - not external fault 4
 x2xxH - not external fault 5
 x4xxH - not external fault 6
 x8xxH - not external fault 7
 1xxxH - not external fault 8
 2xxxH - transfer to drive
 4xxxH - transfer to bypass
 8xxxH - bypass contactor closed

The second 8 inputs are optional and will not be present on all drives.

Local Discrete Outputs [Local outputs]

Linear number: 261
 Minimum value: 0000 Hex
 Maximum Value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the value of the 16 local discrete digital outputs. It is bit encoded as shown below:

xxx1H - ready
 xxx2H - running
 xxx4H - reverse rotation
 xxx8H - fault
 xx1xH - warning
 xx2xH - start fans
 xx4xH - close input contactor
 xx8xH - close output contactor

 x1xxH - close bypass contactor
 x2xxH - at speed command
 x4xxH - in torque limit
 x8xxH - in test mode
 1xxxH - synchronous transfer in progress
 2xxxH - start field supply
 4xxxH - enable field supply
 8xxxH - reset faults

The second 8 outputs are optional and will not be present on all drives.

Pass Code [Pass code]

Linear number: 262
Minimum value: 0
Maximum value: 65535
Analog Output Scaling: N/A

This variable is the encoded value of the terminal pass number. If the terminal pass number is lost or corrupted, the value of the pass number can be determined from the encoded value by consulting the factory.

19 Speed Command Variables**Speed Command 0 [Speed command 0]**

Linear number: 273
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the value of analog speed command 0 from analog input 1L.

Speed Command 8 [Speed command 8]

Linear number: 274
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the value of analog speed command 8 from analog input 1M.

Speed Command 9 [Speed command 9]

Linear number: 275
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the value of the digital speed command from the selected SCANport adapter. Since the inputs from all SCANport adapters are multiplexed through this one variable, only the input from the selected adapter is visible.

Speed Command Input [Speed command in]

Linear number: 276
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the value of the selected speed command input. It is valid whether the drive is running or not.

Speed Command [Speed command]

Linear number: 277
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the drive speed command, which is the input to the speed ramp. It is set to zero when the drive is not running.

Speed Reference [Speed reference]

Linear number: 278
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the drive speed reference, which is the output of the speed ramp.

20 Speed Control Variables**Speed Feedback [Speed feedback]**

Linear number: 289
 Minimum value: -100.0 Hz
 Maximum value: 100.0 Hz
 Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the calculated speed feedback after filtering. The speed feedback is positive for forward rotation and negative for reverse rotation.

Speed Error [Speed error]

Linear number: 290
 Minimum value: -10.00 Hz
 Maximum value: 10.00 Hz
 Analog Output Scaling: 1 V = 0.2 Hz

This variable is the speed error obtained by subtracting the speed feedback from the speed reference. It is useful for checking the step response of the speed loop.

Torque Reference [Torque reference]

Linear number: 291
 Minimum value: -1.500 pu
 Maximum value: 1.500 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the torque reference, which is the output of the speed regulator after the torque rate limit and the motoring and generating torque limits have been applied. A value of 1.00 corresponds to rated torque. It is positive for forward torque and negative for reverse torque.

Prior to Rev 4.60/5.00, this variable was scaled in per unit based on the motor rated kVA and was about 10% lower.

Isq Command [Isq command]

Linear number: 292
 Minimum value: -2.000 pu
 Maximum value: 2.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the Q-axis stator current command obtained by dividing the torque reference by the flux reference. It is positive for motoring and negative for generating.

Icq Command [Icq command]

Linear number: 293
 Minimum value: -1.000 pu
 Maximum value: 1.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the Q-axis capacitor current command. It is an estimate of the Q-axis current provided by the motor filter capacitor.

Iy Command [Iy command]

Linear number: 294
 Minimum value: -2.000 pu
 Maximum value: 2.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the torque current command obtained by subtracting Icq Command from Isq Command.

PWM Pulse number [PWM pulse number]

Linear number: 295
Minimum value: 1
Maximum value: 361
Analog Output Scaling: NA

This variable indicates the number of pulses per cycle for the active PWM mode.

Synchronizing Regulator Error [Sync reg error]

Linear number: 297
Minimum value: -180 degrees
Maximum value: +180 degrees
Analog Output Scaling: 1.0 V = 18 degrees

This variable is the synchronizing regulator error, which is the phase angle between the line voltage and the motor voltage during a synchronous transfer from drive to bypass.

Synchronizing Regulator Output [Sync reg output]

Linear number: 298
Minimum value: -10.0 Hz
Maximum value: +10.0 Hz
Analog Output Scaling: 1.0 V = 0.2 Hz

This variable is the synchronizing regulator output, which is added to the speed regulator error during a synchronous transfer from drive to bypass.

21 Flux Control Variables**Flux Reference [Flux reference]**

Linear number: 305
Minimum value: 0.000 pu
Maximum value: 1.500 pu
Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the rotor flux reference, which varies between a minimum value set by parameter Flux Command No Load and a maximum value set by parameter Flux Command Base Speed. The flux reference varies directly with torque at all speeds, and decreases with speed above Base Speed. The flux reference is also automatically reduced if the current regulator approaches advance limit or retard limit, which can occur when running at high speed and high torque with low line voltage.

Flux Feedback [Flux feedback]

Linear number: 306
Minimum value: 0.000 pu
Maximum value: 1.500 pu
Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the selected flux feedback, either Flux from Voltage, Flux from Current, or a combination of both.

Flux Error [Flux error]

Linear number: 307
Minimum value: -1.500 pu
Maximum value: 1.500 pu
Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the flux error obtained by subtracting the flux feedback from the flux reference.

Isd Command 0 [Isd command 0]

Linear number: 308
Minimum value: 0.000 pu
Maximum value: 1.000 pu
Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the feedforward component of the D-axis stator current command. It is an estimate of the steady state D-axis current and is always positive.

Isd Command 1 [Isd command 1]

Linear number: 309
 Minimum value: -1.000 pu
 Maximum value: 1.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the closed loop correction component of the D-axis stator current command. It is the output of the flux regulator and may be positive or negative.

Isd Command [Isd command]

Linear number: 310
 Minimum value: -1.000 pu
 Maximum value: 1.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the D-axis stator current command, which is the sum of Isd Command 0 and Isd Command 1.

Icd Command [Icd command]

Linear number: 311
 Minimum value: 0.000 pu
 Maximum value: 1.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the D-axis capacitor current command. It is an estimate of the D-axis current provided by the motor filter capacitor.

Ix Command [Ix command]

Linear number: 312
 Minimum value: -1.000 pu
 Maximum value: 1.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the magnetizing current command obtained by subtracting Icd Command from Isd Command. It is positive for lagging current and negative for leading current.

I Field Command [I field command]

Linear number: 314
 Minimum value: 0.000 pu
 Maximum value: 1.000 pu
 Analog Output Scaling: 10.0 V = 1.000 pu

This variable is the current command for the synchronous motor field supply. For synchronous drives, this variable must be assigned to one of the external analog outputs (normally output 4L). An analog output of 10.0 V corresponds to maximum field current, which should be somewhat higher than rated field current. The scaling of the field current command can be adjusted to match the scaling of the field supply current reference input using parameter Analog Scale 4L in Analog Output Parameters. For induction motors this variable is always equal to zero.

[This variable was added in Rev 5.00 and is not present in 4.xx.](#)

22 Current Control Variables**Idc Reference [Idc reference]**

Linear number: 321
 Minimum value: 0.000 pu
 Maximum value: 2.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the dc link current reference.

Idc Feedback [Idc feedback]

Linear number: 322
Minimum value: 0.000 pu
Maximum value: 2.000 pu
Analog Output Scaling: 5.0 V = 1.0 pu
This variable is the measured dc link current feedback.

Idc Error [Idc error]

Linear number: 323
Minimum value: -2.000 pu
Maximum value: 2.000 pu
Analog Output Scaling: 5.0 V = 1.0 pu
This variable is the dc current error obtained by subtracting the dc current feedback from the dc current reference.

V Line [V line]

Linear number: 324
Minimum value: 0.000 pu
Maximum value: 1.500 pu
Analog Output Scaling: 5.0 V = 1.0 pu
This variable is the measured line voltage. A value of 1.000 pu corresponds to rated motor voltage.

Vdc Reference [Vdc reference]

Linear number: 326
Minimum value: -1.000
Maximum value: 1.000
Analog Output Scaling: 10.0 V = 1.0
This variable is the dc voltage reference, which is the output of the current regulator after the advance limit and retard limit have been applied. A value of 1.000 corresponds to maximum positive voltage (motoring) and a value of -1.000 corresponds to maximum negative voltage (regenerating) regardless of the direction of motor rotation.

Alpha Line [Alpha line]

Linear number: 327
Minimum value: 0.0 deg
Maximum value: 180.0 deg
Analog Output Scaling: 10.0 V = 360 degrees
This variable is the line converter firing angle, which is equal to the inverse cosine of the dc voltage reference. It is in the range 0 to 90 degrees for motoring and 90 to 180 degrees for generating.

Alpha Machine [Alpha machine]

Linear number: 328
Minimum value: 0.0 deg
Maximum value: 359.9 deg
Analog Output Scaling: 10.0 V = 360 degrees
This variable is the machine converter firing angle. It is in the range 0 to 90 degrees for leading generating, 90 to 180 degrees for leading motoring, 180 to 270 degrees for lagging motoring, and 270 to 360 degrees for lagging generating.

23 Motor Model Variables**Stator Frequency [Stator frequency]**

Linear number: 337
 Minimum value: 0.0 Hz
 Maximum value: 100.0 Hz
 Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the measured stator frequency of the motor. It is positive for both directions of rotation.

Isd [Isd]

Linear number: 338
 Minimum value: -2.000 pu
 Maximum value: 2.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the calculated D-axis or magnetizing component of the stator current. It is positive for magnetizing and negative for demagnetizing.

Isq [Isq]

Linear number: 339
 Minimum value: -2.000 pu
 Maximum value: 2.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the calculated Q-axis or torque component of the stator current. It is positive for motoring and negative for generating.

I Stator [I stator]

Linear number: 340
 Minimum value: 0.000 pu
 Maximum value: 2.000 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the stator current magnitude.

Flux from Current [Fix from current]

Linear number: 341
 Minimum value: 0.000 pu
 Maximum value: 1.500 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the calculated rotor flux magnitude derived from the measured current feedback and the motor model parameters. It is not valid at stator frequencies below about 4 Hz unless the optional tachometer is installed.

Flux from Voltage [Fix from voltage]

Linear number: 342
 Minimum value: 0.000 pu
 Maximum value: 1.500 pu
 Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the measured rotor flux magnitude as determined by the hardware flux reconstruction using the stator voltage and current feedback. It is not valid at stator frequencies below approximately 4 Hz.

Slip Frequency [Slip frequency]

Linear number: 343
 Minimum value: -2.00 Hz
 Maximum value: 2.00 Hz
 Analog Output Scaling: 1.0 V = 3.2 Hz

This variable is the calculated slip frequency of the motor. It is positive for motoring and negative for generating. For synchronous motors, this variable is always zero.

V Stator [V stator]

Linear number: 344
Minimum value: 0.000 pu
Maximum value: 1.500 pu
Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the calculated stator voltage magnitude. It varies with both speed and torque and if the flux command is set correctly should be about 1.0 pu at rated speed and rated load. The stator voltage may be less than 1.0 pu at rated speed if the load torque is less than rated or the line voltage is low.

Torque [Torque]

Linear number: 345
Minimum value: -1.500
Maximum value: 1.500
Analog Output Scaling: 5.0 V = 1.0

This variable is the calculated motor torque. A value of 1.000 corresponds to rated torque. It is positive for forward torque and negative for reverse torque.

Prior to Rev 4.60/5.00, this variable was scaled in per unit based on the motor rated kVA and was about 10% lower.

Motor Power [Motor power]

Linear number: 346
Minimum value: -1.500
Maximum value: 1.500
Analog Output Scaling: 5.0 V = 1.0

This variable is the calculated motor power. A value of 1.000 corresponds to rated power. It is positive for motoring and negative for generating regardless of the direction of rotation.

Prior to Rev 4.60/5.00, this variable was scaled in per unit based on the motor rated kVA and was about 10% lower.

V Neutral Motor [V neutral motor]

Linear number: 347
Minimum value: 0.000 pu
Maximum value: 1.500 pu
Analog Output Scaling: 5.0 V = 1.0 pu

This variable is the measured motor neutral to ground voltage.

Tachometer Feedback [Tach feedback]

Linear number: 348
Minimum value: -100.0 Hz
Maximum value: 100.0 Hz
Analog Output Scaling: 1.0 V = 12.8 Hz

This variable is the motor speed measured using the optional tachometer or encoder. It is positive for forward rotation and negative for reverse rotation.

24 Analog I/O Variables**Analog Input 1L [Analog input 1L]**

Linear number: 353
Minimum value: -10.00 V
Maximum value: 9.99 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the value in volts of analog input 1L (analog speed command 0).

Analog Input 1M [Analog input 1M]

Linear number: 355
Minimum value: -10.00 V
Maximum value: 9.99 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the value in volts of analog input 1M (analog speed command 8).

Analog Input 2M [Analog input 2M]

Linear number: 356
Minimum value: -10.00 V
Maximum value: 9.99 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the value in volts of analog input 2M (static pressure in converter cubicle).

Analog Output 4L [Analog output 4L]

Linear number: 365
Minimum value: -10.00 V
Maximum value: 9.92 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the nominal value in volts of the variable assigned to analog output 4L after scaling and offset addition.

This variable was added in Rev 5.00 and is not present in 4.xx. Prior to Rev 4.60/5.00 linear number 365 was assigned to variable SCANport Input, which has been moved to the Control Owners group and renumbered 398.

Analog Output 5L [Analog output 5L]

Linear number: 357
Minimum value: -10.00 V
Maximum value: 9.92 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the nominal value in volts of the variable assigned to analog output 5L after scaling and offset addition.

Analog Output 6L [Analog output 6L]

Linear number: 358
Minimum value: -10.00 V
Maximum value: 9.92 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the nominal value in volts of the variable assigned to analog output 6L after scaling and offset addition.

Analog Output 4M [Analog output 4M]

Linear number: 366
Minimum value: -10.00 V
Maximum value: 9.92 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the nominal value in volts of the variable assigned to analog output 4M after scaling and offset addition.

This variable was added in Rev 5.00 and is not present in 4.xx. Prior to Rev 4.60/5.00 linear number 366 was assigned to variable SCANport Output, which has been moved to the Control Owners group and renumbered 399.

Analog Output 5M [Analog output 5M]

Linear number: 359
Minimum value: -10.00 V
Maximum value: 9.92 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the nominal value in volts of the variable assigned to analog output 5M after scaling and offset addition.

Analog Output 6M [Analog output 6M]

Linear number: 360
Minimum value: -10.00 V
Maximum value: 9.92 V
Analog Output Scaling: 1.0 V = 1.0 V

This variable is the nominal value in volts of the variable assigned to analog output 6M after scaling and offset addition.

Current Meter [Current meter]

Linear number: 361
Minimum value: 0 A
Maximum value: 1000 A
Analog Output Scaling: 10 V = 128 A

This variable is the motor current meter. It is used by the programming terminal and may also be assigned to analog output 6L to drive an optional analog meter.

Voltage Meter [Voltage meter]

Linear number: 362
Minimum value: 0 V
Maximum value: 8000V
Analog Output Scaling: 10 V = 4096 V

This variable is the motor voltage meter. It is used by the programming terminal and may also be assigned to analog output 5L to drive an optional analog meter.

Speed Meter [Speed meter]

Linear number: 363
Minimum value: -4500 rpm
Maximum value: 4500 rpm
Analog Output Scaling: 10 V = 4096 rpm

This variable is the motor speed meter. It is used by the programming terminal and may also be assigned to analog output 5M to drive an optional analog meter.

Power Meter [Power meter]

Linear number: 364
Minimum value: -7500 kw
Maximum value: 7500 kw
Analog Output Scaling: 10 V = 1024 kw

This variable is the motor power meter. It is used by the programming terminal and may also be assigned to analog output 6M to drive an optional analog meter.

Ground Fault Current [Gnd flt current]

Linear number: 367
 Minimum value: 0.0 A
 Maximum value: 10.0 A
 Analog Output Scaling: 1.0 V = 1.28 A

This variable is the measured ground fault current from the optional ground fault current transformer. The ground fault CT is used only for drives without an input isolation transformer, and measures the zero sequence input current of the drive (not the motor current).

Control Board Temperature [Cntrl board temp]

Linear number: 368
 Minimum value: -40°C
 Maximum value: 100°C
 Analog Output Scaling: 10.0 V = 62.5°C

This variable is the measured temperature of the drive control boards, which is slightly higher than the ambient air temperature in the control cubicle. If the measured temperature exceeds 60°C a “Control temp warning” will be displayed, and if the temperature exceeds 70°C the drive will trip on a “Control temp” fault.

[This variable was added in Rev 5.00 and is not present in 4.xx.](#)

25 Fault and Warning Variables

There are eight 16-bit fault words. This allows for a maximum of 128 faults and warnings, but the actual total is less than this because some bits are not used. Each fault is assigned a class. Class 1 faults cause the drive to trip immediately. Class 2 faults cause the drive to decelerate to a stop at the normal ramp rate before tripping. Class 3 faults are merely warnings and cause no action to be taken. There are two variables for class 1 faults (one for the line converter and one for the machine converter), one variable for class 2 faults, and four variables for class 3 faults (warnings). The eighth variable is for external faults. Unlike the other faults, the class of each of the external faults is not predetermined but is specified by 16 fault class parameters in the External Fault Parameters group.

Fault Flags 1L [Fault flags 1L]

Linear number: 369
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the line converter class 1 fault flags. It is bit encoded as shown below:

xxx1H - line self test
 xxx2H - line parameter checksum
 xxx4H - software watchdog
 xxx8H - hardware watchdog
 xx1xH - software overcurrent
 xx2xH - hardware overcurrent
 xx4xH - ac overvoltage
 xx8xH - dc overvoltage
 x1xxH - line phasing (Rev 5.xx) / 12P phasing (Rev 4.xx)
 x2xxH – ground fault
 x4xxH - line thyristor open
 x8xxH - line thyristor short
 1xxxH - ac control power
 2xxxH - line unbalance (current if running, voltage if not running)
 4xxxH - input contactor open
 8xxxH - pulse number

Fault Flags 1M [Fault flags 1M]

Linear number: 370
Minimum value: 0000 Hex
Maximum value: FFFF Hex
Analog Output Scaling: N/A

This variable is the machine converter class 1 fault flags. It is bit encoded as shown below:

xxx1H - motor self test
xxx2H - motor parameter checksum
xxx4H - software watchdog
xxx8H - hardware watchdog
xx1xH - software overcurrent
xx2xH - hardware overcurrent
xx4xH - ac overvoltage
xx8xH - dc overvoltage
x1xxH - motor stall
x2xxH - dc/dc converter failure (Rev 5.32 only)
x4xxH - motor thyristor open
x8xxH - motor thyristor short
1xxxH - dc control power
2xxxH - motor unbalance (current or flux)
4xxxH - output contactor open
8xxxH - no Vdc feedback

Fault Flags 2 [Fault flags 2]

Linear number: 371
Minimum value: 0000 Hex
Maximum value: FFFF Hex
Analog Output Scaling: N/A

This variable is the class 2 fault flags. It is bit encoded as shown below:

xxx1H - drive overload
xxx2H - motor overload
xxx4H - motor overspeed
xxx8H - control overtemperature (> 70°C) (not used in Rev 4.xx)
xx1xH - synchronous transfer failed
xx2xH - neutral overvoltage
xx4xH - SCANport fault
xx8xH - fan loss fault (Rev 5.3x only)
x1xxH - overtemperature 1
x2xxH - overtemperature 2
x4xxH - overtemperature 3
x8xxH - undertemperature (1557M only)
1xxxH - overtemperature 5
2xxxH - overtemperature 6
4xxxH - overtemperature 7
8xxxH - incompatible firmware for drive control or communications processor boards

Fault Flags External [Fault flags ext]

Linear number: 372
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the external fault flags. Unlike the other faults, the fault message and the class of each of these faults is user definable. It is bit encoded as shown below:

xxx1H - external 1 [512]
 xxx2H - external 2 [513]
 xxx4H - external 3 [514]
 xxx8H - external 4 [515]
 xx1xH - external 5 [516]
 xx2xH - external 6 [517]
 xx4xH - external 7 [518]
 xx8xH - external 8 [519]
 x1xxH - external 9 [520]
 x2xxH - external 10 [521]
 x4xxH - external 11 [522]
 x8xxH - external 12 [523]
 1xxxH - external 13 [524]
 2xxxH - external 14 [525]
 4xxxH - external 15 [526]
 8xxxH - external 16 [527]

Warning Flags A [Warning flags A]

Linear number: 373
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the maskable drive warning flags. It is bit encoded as shown below.

xxx1H - drive overload warning
 xxx2H - motor overload warning
 xxx4H - line under voltage
 xxx8H - line reverse sequence
 xx1xH - input contactor open
 xx2xH - input contactor closed
 xx4xH - output contactor open
 xx8xH - output contactor closed
 x1xxH - bypass contactor open
 x2xxH - bypass contactor closed
 x4xxH - tach loss
 x8xxH - h/w overcurrent warning
 1xxxH - h/w overvoltage warning
 2xxxH - tach rotation
 4xxxH - line synchronization loss
 8xxxH - dc/dc converter failure (Rev 5.32 only)

Warning Flags B [Warning flags B]

Linear number: 374
 Minimum value 0000 HEX
 Maximum value: FFFF Hex
 Default Value: N/A

This variable is the non-maskable drive warning flags. It is bit encoded as shown below:

xxx1H- rated rpm warning
 xxx2H- PWM frequency too high warning
 xxx4H- rated current feedback out of range
 xxx8H- filter capacitor out of range
 xx1xH- not used
 xx2xH- not used
 xx4xH- not used
 xx8xH- not used
 x1xxH- control overtemperature warning (> 60°C) (not used in Rev 4.xx)
 x2xxH- fan loss warning (Rev 5.3x only)
 x4xxH- synchronous transfer failed
 x8xxH- software error
 1xxxH- communications processor board failure
 2xxxH- SCANport adapter loss
 4xxxH- speed command loss
 8xxxH- local control loss

PLC Error Flags [PLC error flags]

Linear number: 376
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Analog Output Scaling: N/A

This variable is the PLC Remote I/O error flags. It is bit encoded as shown below:

xxx1H - Link A1 value out of range
 xxx2H - Link A2 value out of range
 xxx4H - Link B1 value out of range
 xxx8H - Link B2 value out of range
 xx1xH - Link C1 value out of range
 xx2xH - Link C2 value out of range
 xx4xH - Link D1 value out of range
 xx8xH - Link D2 value out of range
 x1xxH - Link A1 operation error
 x2xxH - Link A2 operation error
 x4xxH - Link B1 operation error
 x8xxH - Link B2 operation error
 1xxxH - Link C1 operation error
 2xxxH - Link C2 operation error
 4xxxH - Link D1 operation error
 8xxxH - Link D2 operation error

An operation error will be indicated if the corresponding link is not defined, or if an attempt is made to modify a parameter or variable that cannot be changed.

Autotune Warning [Autotune warn]

Linear number: 377
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Analog Output scaling: NA

This variable is the autotune warning flags. It is bit encoded as shown below:

xxx1H Tuning abort
 xxx2H In test mode
 xxx4H Regulator in limit
 xxx8H R stator high
 xx1xH Time limit
 xx2xH Inertia high
 xx4xH L commutation low
 xx8xH L commutation high
 x1xxH T dc low
 x2xxH T dc high
 x4xxH L leakage low
 x8xxH L leakage high
 1xxxH L magnetizing low
 2xxxH L magnetizing high
 4xxxH T rotor low
 8xxxH T rotor high

Fault Output [Fault Output]

Linear number: 382
 Minimum value: 0.00 V
 Maximum value: 9.92 V
 Analog Output Scaling: 1.0 V = 1.0 V

This variable is intended to be assigned to one of the diagnostic analog outputs and used to trigger an oscilloscope or chart recorder when a class 1 fault occurs. It will jump from zero to full scale when a fault occurs and will return to zero when the faults are cleared.

[This variable was added in Rev 4.60/5.10.](#)

26 Control Owner Variables

The variables in this group show which adapters are controlling the various drive functions. All the control owner variables in this group are bit encoded as shown below:

xxx1H - adapter 0
 xxx2H - adapter 1
 xxx4H - adapter 2
 xxx8H - adapter 3
 xx1xH - adapter 4
 xx2xH - adapter 5
 xx4xH - adapter 6
 xx8xH - adapter 7

A bit that is set indicates that the function is controlled by the corresponding adapter.

Stop Owner [Stop owner]

Linear number: 385
 Minimum value: 00 Hex
 Maximum value: FF Hex
 Analog Output Scaling: NA

This variable indicates which adapters are issuing a stop command.

Local Owner [Local owner]

Linear number: 386

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapter has exclusive local control of the drive.

Start Owner [Start owner]

Linear number: 387

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapters are issuing a start command.

Direction Owner [Direction owner]

Linear number: 388

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapters are issuing a direct command.

Jog Owner [Jog owner]

Linear number: 389

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapters are issuing a jog command.

Fault Reset Owner [Fault reset owner]

Linear number: 391

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapters are issuing a fault reset command.

Speed Command Owner [Speed command owner]

Linear number: 392

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapter is selecting the drive speed command.

Synchronous Transfer Owner [Synchronous transfer owner]

Linear number: 393

Minimum value: 00 Hex

Maximum value: FF Hex

Analog Output Scaling: N/A

This variable indicates which adapter is issuing a synchronous transfer command.

SCANport Input [SCANport input]

Linear number: 398

Minimum value: 0

Maximum value: 32767

Analog Output Scaling: 1.0 V = 3276.7

This variable is the SCANport speed command input before scaling.

Prior to Rev 4.60/5.00 this variable was located in the Analog I/O group with a linear number of 365.

SCANport Output [SCANport output]

Linear number: 399
Minimum value: -4500 rpm
Maximum value: 4500 rpm
Analog Output Scaling: 10 V = 4096 rpm

This variable is the SCANport output, and indicates the motor speed in rpm.

Prior to Rev 4.60/5.00 this variable was located in the Analog I/O group with a linear number of 366.

Not Used [Not used]

Linear number: 400
Minimum value: 0
Maximum value: 65535
Analog Output Scaling: N/A

This is a dummy variable used to represent all non-existent variables in order to satisfy SCANport requirements.

Parameters and Variables Listed by Group

Categories: 1 - rating or configuration parameter set at the factory
 2 - application parameter set at the factory or at commissioning
 3 - tuning parameter set at commissioning
 S - synchronous drive parameter not used for induction motors

All other parameters are normally left at the default setting.

1 Feature Select

	Name	Minimum	Maximum	Default	Units	Cat.
1	Contactors Configuration	0	7	0		2
3	Automatic Restart Delay	0.000	10.000	0.000	sec	2
4	Test Mode	0	4	0		
6	Speed Command Select 0	1	15	1		2
7	Speed Command Select	0	15	NA		
8	Reverse Enable	0	1	0		2
9	Speed Command Select 8	1	15	9		2
10	Contactors Open Delay	0.0	57.0	0.0	min	2
13	Parameter Level	0	3	2		
15	Drive Control FRN	0.00	99.99	NA		
16	Communications Proc FRN	0.00	99.99	NA		

2 Nameplate Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
17	Rated Line Frequency	50	60	60	Hz	1
20	Capacitor kvar	1	7500	100	kvar	1
21	Capacitor Volts	1000	10000	2400	V	1
22	Rated Motor Volts	1000	7200	2300	V	1
23	Rated Motor Amps	10	1000 or 1400	60	A	1
24	Rated Motor kw	30	7500 or 10000	187	kw	1
25	Rated Motor hp	40	10000 / 13400	250	hp	1
26	Rated Motor rpm	150.0	3600.0	1185.0	rpm	1
27	Link Inductance	1.0	600.0	64.0	mh	1
28	Capacitor Frequency	50	60	60	Hz	1
29	Rated Motor Frequency	40	90	60	Hz	1
30	Motor Type	0	1	0		1
31	Service Factor	0.75	1.25	1.00		1
32	Drive Type	0	1	0		1

3 Speed Command Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
33	Preset Speed Command 1	0.5	90.0	30.0	Hz	
34	Preset Speed Command 2	0.5	90.0	35.0	Hz	
35	Preset Speed Command 3	0.5	90.0	40.0	Hz	
40	Preset Jog Speed	1.0	60.0	6.0	Hz	
41	Speed Command 0 Minimum	-127.0	127.0	6.0	Hz	2
42	Speed Command 0 Maximum	0.0	127.0	60.0	Hz	2
43	Speed Command 8 Minimum	-127.0	127.0	6.0	Hz	2
44	Speed Command 8 Maximum	0.0	127.0	60.0	Hz	2
45	Speed Command 9 Minimum	0.0	127.0	6.0	Hz	2
46	Speed Command 9 Maximum	0.0	127.0	60.0	Hz	2
47	Speed Command Minimum	1.0	75.0	6.0	Hz	2
48	Speed Command Maximum	1.0	75.0	60.0	Hz	2

4 Skip Speed Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
49	Skip Speed 1	6.0	90.0	90.0	Hz	
50	Skip Speed 2	6.0	90.0	90.0	Hz	
51	Skip Speed 3	6.0	90.0	90.0	Hz	
52	Skip Speed 4	6.0	90.0	90.0	Hz	
53	Skip Speed Band 1	0.0	2.0	0.0	Hz	
54	Skip Speed Band 2	0.0	2.0	0.0	Hz	
55	Skip Speed Band 3	0.0	2.0	0.0	Hz	
56	Skip Speed Band 4	0.0	2.0	0.0	Hz	

5 Speed Ramp Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
65	Acceleration Time 1	0	999	5	sec	2
66	Acceleration Time 2	0	999	3	sec	2
67	Acceleration Time 3	0	999	14	sec	2
68	Acceleration Time 4	0	999	3	sec	2
69	Deceleration Time 1	0	999	3	sec	2
70	Deceleration Time 2	0	999	3	sec	2
71	Deceleration Time 3	0	999	14	sec	2
72	Deceleration Time 4	0	999	3	sec	2
73	Ramp Speed 1	5.0	6.0	5.0	Hz	2
74	Ramp Speed 2	5.0	100.0	12.0	Hz	2
75	Ramp Speed 3	5.0	100.0	54.0	Hz	2
76	Ramp Speed 4	5.0	100.0	60.0	Hz	2
77	Coast Speed	2	100	2	Hz	2
78	Ramp Start delay	1	10	3	sec	2
80	Ramp test step	0.0	30.0	0.0	Hz	

6 Speed Control Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
81	Spd Regulator Bandwidth	0.5	5.0	1.0	r/s	2
82	Total Inertia	0.10	100.0	1.00	sec	3
83	Torque Rate Limit	0.00	60.00	10.00		
84	Torque Limit Motoring	0.00	1.50	1.00		
85	Torque Limit Braking	0.00	1.50	0.80		
86	Torque Command 0	0.00	1.50	0.15		3
87	Torque Command 1	0.00	1.50	0.15		3
88	Speed Reference Step	0.0	2.0	0.0	Hz	
89	Speed Feedback Mode	0	1	0		2
90	Torque Control Mode	0	5	1		2
91	Torque Command External	-1.500	1.500	0.000		
92	Torque Command Minimum	0.00	1.50	1.50		
93	Speed Error Deadband	0.0	5.0	0.0	Hz	
110	Speed Feedback Filter	0	50	0	r/s	2
111	Torque Rate Limit 0	0.00	60.00	1.00		

7 Flux Control Parameters

Name	Minimum	Maximum	Default	Units	Cat.
97 Flux Regulator Bandwidth	1	30	10	r/s	
98 Base Speed	30.0	100.0	60.0	Hz	2
100 Flux Command Base Speed	0.300	1.500	0.900	pu	3
102 Flux Reference Step	0.000	0.100	0.000	pu	
103 Flux Command No Load	0.300	1.500 **0.600	0.700 **0.600	pu	
104 I Field Command Bandwidth	0.1	10.0	1.0	r/s	3, S
105 Icd Command Gain	0.0	1.0	0.5		3, S

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8 Current Control Parameters

Name	Minimum	Maximum	Default	Units	Cat.
113 Current Regulator Bandwidth	0	400	200	r/s	
114 DC Link Inductance	0.00	10.00	N/A	pu	
115 DC Link Time Constant	0.010	0.100	0.040	sec	3
117 Commutation Inductance	0.00	0.50	0.10	pu	3
119 DC Current Test Command	0.000	1.000	0.000	pu	
120 DC Current Reference Step	0.000	1.000	0.000	pu	

9 Motor Model Parameters

Name	Minimum	Maximum	Default	Units	Cat.
129 Stator Resistance	0.00	0.20	0.00	pu	3
130 Total Leakage Inductance	0.00	0.74	0.20	pu	3
131 Magnetizing Inductance	1.00	15.00	4.00	pu	3
132 Rotor Time Constant	0.10	10.00	1.00	sec	3
133 Filter Capacitor	0.00	2.00	NA	pu	
134 L Magnetizing Measured	1.00	15.00	NA	pu	
135 Lmd	0.10	10.00	1.00	pu	3, S

10 Converter Parameters

Name	Minimum	Maximum	Default	Units	Cat.
145 Series Thyristor Line	1	6	1		1
146 Series Thyristor Motor	1	6	1		1
147 Redundant Thyristor Line	0	1	0		1
148 Redundant Thyristor Motor	0	1	0		1
149 CT Ratio Line	10	10000	200		1
150 CT Ratio Motor	10	10000	2500		1
151 CT Burden Line	1.0	1000.0	15.0	ohms	1
152 CT Burden Motor	1.0	1000.0	39.0	ohms	1
153 Pulse Number	6	18 ^{5.xx} 12 ^{4.xx}	6		1
154 CT configuration	2	3	2		1
155 PWM Frequency Maximum	150 or 200	280 or 560	200	Hz	
156 Flux Minimum	0.20	2.00	0.40	pu	
157 CT Ratio Ground Fault	10	10000	2000		1
158 CT Burden Ground Fault	10	10000	1000	ohm	1
159 Current Fdbk Rated Line	0.000	5.000	NA	V	
160 Current Fdbk Rated Motor	0.000	5.000	NA	V	

11 Line Converter Protection Parameters

Name	Minimum	Maximum	Default	Units	Cat.
161 Line Overcurrent Trip	0.00	2.00	1.50	pu	
162 Line Overcurrent Delay	0.000	0.040	0.004	sec	
163 Line Overload Trip	0.20	1.15	1.00	pu	
164 Line Overload Delay	0	61	60	sec	
165 Line Overvoltage Trip	0.00	1.50	1.20	pu	
166 Line Overvoltage Delay	0.000	10.000	0.050	sec	
167 Line Undervoltage Trip	0.70	1.50	0.85	pu	
168 Line Undervoltage Delay	0.010	0.040	0.020	sec	
169 DC Link Overcurrent Trip	0.10	2.00	2.00	pu	
170 DC Link Overcurrent Delay	0.000	0.040 **0.004	0.004	sec	
171 Gnd Flt Overcurrent Trip	0.0	1.0	0.5	A	
172 Gnd Flt Overcurrent Delay	0.000	1.000	0.050	sec	
173 Line DC Overvoltage Trip	0.10	1.47	1.47	pu	
174 Line DC Overvoltage Delay	0.000	0.040	0.010	sec	
175 Fan Loss Trip	0.0	9.9	2.0	V	
176 Fan Loss Delay	0.0	60.0	5.0	sec	

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12 Motor Converter Protection Parameters

Name	Minimum	Maximum	Default	Units	Cat.
177 Motor Overcurrent Trip	0.00	2.00	1.50	pu	
178 Motor Overcurrent Delay	0.000	0.100	0.020	sec	
179 Motor Overload Trip	0.20	1.15	1.00	pu	2
180 Motor Overload Delay	0	61	60	sec	
181 Motor Overvoltage Trip	0.00	1.50	1.20	pu	
182 Motor Overvoltage Delay	0.000	10.000	0.050	sec	
183 Motor Unbalance Trip	0.00	1.00	0.10	pu	
184 Motor Unbalance Delay	0.00	10.00	2.00	sec	
185 Motor Overspeed Trip	10	100	66	Hz	2
186 Motor Overspeed Delay	0.00	10.00	0.50	sec	
187 Motor DC Overvoltage Trip	0.10	1.47	1.47	pu	
188 Motor DC Overvoltage Delay	0.000	0.040 **0.004	0.004	sec	
189 Gnd Flt Overvoltage Trip	0.00	1.50	0.20	pu	2
190 Gnd Flt Overvoltage Delay	0.000	5.000	0.500	sec	
191 Motor Stall Delay	0.00	10.00	2.00	sec	
192 V Stator Min Thyristor Fault	0.10	0.50	0.25	pu	

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13 Analog Output Parameters

Name	Minimum	Maximum	Default	Units	Cat.
193 Analog Offset 5L	-10.00	9.92	0.00	V	
194 Analog Offset 6L	-10.00	9.92	0.00	V	
195 Analog Offset 5M	-10.00	9.92	0.00	V	
196 Analog Offset 6M	-10.00	9.92	0.00	V	
197 Analog Scale 5L	0.000	10.000	1.000		1
198 Analog Scale 6L	0.000	10.000	1.000		1
199 Analog Scale 5M	0.000	10.000	1.000		1
200 Analog Scale 6M	0.000	10.000	1.000		1
201 Analog Offset 4L	-10.00	9.92	0.00	V	
202 Analog Offset 4M	-10.00	9.92	0.00	V	
203 Analog Scale 4L	0.000	10.000	1.000		1
204 Analog Scale 4M	0.000	10.000	1.000		1

14 External Fault Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
209	External Fault 1	1	3	2		2
210	External Fault 2	1	3	2		2
211	External Fault 3	1	3	2		2
212	External Fault 4	1	3	2		2
213	External Fault 5	1	3	2		2
214	External Fault 6	1	3	2		2
215	External Fault 7	1	3	2		2
216	External Fault 8	1	3	2		2
217	External Fault 9	1	3	2		2
218	External Fault 10	1	3	2		2
219	External Fault 11	1	3	2		2
220	External Fault 12	1	3	2		2
221	External Fault 13	1	3	2		2
222	External Fault 14	1	3	2		2
223	External Fault 15	1	3	2		2
224	External Fault 16	1	3	2		2

15 Autotune Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
12	Autotune Select	0	8	0		
124	Autotune Idc Command	0.100	0.900	0.500	pu	
125	Autotune Idc Step	0.000	0.500	0.250	pu	
126	Autotune Idc Bandwidth	10	100	50	r/s	
94	Autotune Speed Command	20.0	50.0	30.0	Hz	
96	Autotune Torque Step	0.050	0.500	0.100		
107	Autotune Isd Step	0.01	0.20	0.10	pu	S
127	Autotune Commutation Induct.	0.00	0.50	0.00	pu	
128	Autotune dc link Time Constant	0.000	0.160	0.000	sec	
140	Autotune Stator Resistance	0.00	0.20	0.00	pu	
141	Autotune Leakage Inductance	0.00	0.74	0.00	pu	
142	Autotune Magnetizing Induct.	0.00	15.00	0.00	pu	
143	Autotune Rotor Time Constant	0.00	10.00	0.00	sec	
139	Autotune Lmd	0.00	10.00	0.00	pu	S
144	Autotune Inertia	0.00	100.00	0.00	sec	

16 Option Parameters

	Name	Minimum	Maximum	Default	Units	Cat.
225	Sync Regulator Gain	0.0	7.9	1.0		3
226	Sync Transfer Lead Angle	-90	90	0	deg	3
227	Sync Transfer Off Delay	0.000	0.500	0.100	sec	3
228	Sync Error Maximum	0	30	0	deg	3
229	Synchronizing Time	0.1	10.0	1.0	sec	
230	Sync Transfer Time	0.1	57.0	1.0	min	2
232	External Fault Input	0000H	FFFFH	0000H	Hex	
233	Tach Type	1	2 or 3 ^{5,20 only}	2		1
234	Tach Pulse Per Rev.	120	4096	360	ppr	1
235	Tach Loss Trip	0.0	10.0	2.0	Hz	
236	Tach Loss Delay	0.00	1.00	0.10	sec	
237	Tach Select	0	3	0		
238	Encoder Offset	0	359	0	deg	3, S
239	Encoder Reverse	0	1	0		3, S

17 Control Mask Parameters

	Name	Minimum	Maximum	Default	Units
241	Logic Mask	00H	FFH	FFH	
242	Local Mask	00H	FFH	FFH	
243	Start Mask	00H	FFH	FFH	
244	Direction Mask	00H	FFH	FFH	
245	Jog Mask	00H	FFH	FFH	
247	Fault Reset Mask	00H	FFH	FFH	
248	Speed Command Mask	00H	FFH	FFH	
249	Sync Transfer Mask	00H	FFH	FFH	

18 Status Variables

	Name	Minimum	Maximum	1.0V =	Units
257	Logic Command	0000H	FFFFH	NA	Hex
258	Logic Status 1	0000H	FFFFH	NA	Hex
260	Local Discrete Inputs	0000H	FFFFH	NA	Hex
261	Local Discrete Outputs	0000H	FFFFH	NA	Hex
262	Pass Code	0	65535	NA	

19 Speed Command Variables

	Name	Minimum	Maximum	1.0V =	Units
273	Speed Command 0	-100.0	100.0	12.8	Hz
274	Speed Command 8	-100.0	100.0	12.8	Hz
275	Speed Command 9	-100.0	100.0	12.8	Hz
276	Speed Command Input	-100.0	100.0	12.8	Hz
277	Speed Command	-100.0	100.0	12.8	Hz
278	Speed Reference	-100.0	100.0	12.8	Hz

20 Speed Control Variables

	Name	Minimum	Maximum	1.0V =	Units
289	Speed Feedback	-100.0	100.0	12.8	Hz
290	Speed Error	-10.00	10.00	0.2	Hz
291	Torque Reference	-1.500	1.500	0.2	
292	Isq Command	-2.000	2.000	0.2	pu
293	Icq Command	-1.000	1.000	0.2	pu
294	Iy Command	-2.000	2.000	0.2	pu
295	PWM Pulse Number	1	361	NA	
297	Sync Regulator Error	-180	180	18	deg
298	Sync Regulator Output	-10.00	10.00	0.2	Hz

21 Flux Control Variables

	Name	Minimum	Maximum	1.0V =	Units
305	Flux Reference	0.000	1.500	0.2	pu
306	Flux Feedback	0.000	1.500	0.2	pu
307	Flux Error	-1.500	1.500	0.2	pu
308	Isd Command 0	0.000	1.000	0.2	pu
309	Isd Command 1	-1.000	1.000	0.2	pu
310	Isd Command	-1.000	1.000	0.2	pu
311	Icd Command	0.000	1.000	0.2	pu
312	Ix Command	-1.000	1.000	0.2	pu
314	I Field Command	0.000	1.000	0.1	pu

22 Current Control Variables

	Name	Minimum	Maximum	1.0V =	Units
321	Idc Reference	0.000	2.000	0.2	pu
322	Idc Feedback	0.000	2.000	0.2	pu
323	Idc Error	-2.000	2.000	0.2	pu
324	V Line	0.000	1.500	0.2	pu
326	Vdc Reference	-1.000	1.000	0.1	
327	Alpha Line	0.0	180.0	36	deg
328	Alpha Machine	0.0	359.9	36	deg

23 Motor Model Variables

	Name	Minimum	Maximum	1.0V =	Units
337	Stator Frequency	0.0	100.0	12.8	Hz
338	Isd	-2.000	2.000	0.2	pu
339	Isq	-2.000	2.000	0.2	pu
340	I Stator	0.000	2.000	0.2	pu
341	Flux from Current	0.000	1.500	0.2	pu
342	Flux from Voltage	0.000	1.500	0.2	pu
343	Slip Frequency	-2.00	2.00	3.2	Hz
344	V Stator	0.000	1.500	0.2	pu
345	Torque	-1.500	1.500	0.2	
346	Motor Power	-1.500	1.500	0.2	
347	V Neutral Motor	0.000	1.500	0.2	pu
348	Tach Feedback	-100.0	100.0	12.8	Hz

24 Analog I/O Variables

	Name	Minimum	Maximum	1.0V =	Units
353	Analog Input 1L	-10.00	9.99	1.0	V
355	Analog Input 1M	-10.00	9.99	1.0	V
356	Analog Input 2M	-10.00	9.99	1.0	V
357	Analog Output 5L	-10.00	9.92	1.0	V
358	Analog Output 6L	-10.00	9.92	1.0	V
359	Analog Output 5M	-10.00	9.92	1.0	V
360	Analog Output 6M	-10.00	9.92	1.0	V
361	Current Meter	0	1000	12.8	A
362	Voltage Meter	0	8000	409.6	V
363	Speed Meter	-4500	4500	409.6	rpm
364	Power Meter	-7500	7500	102.4	kw
365	Analog Output 4L	-10.00	9.92	1.0	V
366	Analog Output 4M	-10.00	9.92	1.0	V
367	Gnd Flt Current	0.0	10.0	1.28	A
368	Control Board Temperature	-40	100	6.25	C

25 Fault and Warning Variables

	Name	Minimum	Maximum	1.0V =	Units
369	Fault Flags 1L	0000H	FFFFH	NA	
370	Fault Flags 1M	0000H	FFFFH	NA	
371	Fault Flags 2	0000H	FFFFH	NA	
372	Fault Flags External	0000H	FFFFH	NA	
373	Warning Flags A	0000H	FFFFH	NA	
374	Warning Flags B	0000H	FFFFH	NA	
376	PLC Error Flags	0000H	FFFFH	NA	
377	Autotune Warning Flags	0000H	FFFFH	NA	
382	Fault Output	0.00	9.92	1.0V	V

26 Control Owner Variables

	Name	Minimum	Maximum	1.0V =	Units
385	Stop Owner	00H	FFH	NA	
386	Local Owner	00H	FFH	NA	
387	Start Owner	00H	FFH	NA	
388	Direction Owner	00H	FFH	NA	
389	Jog Owner	00H	FFH	NA	
391	Fault Reset Owner	00H	FFH	NA	
392	Speed Command Owner	00H	FFH	NA	
393	Sync Transfer Owner	00H	FFH	NA	
398	SCANport Input	0	32767	3276.7	
399	SCANport Output	-4500	4500	409.6	rpm
400	Not Used	0	65535	NA	

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Chapter Objectives

This chapter describes how you use the terminal to modify and obtain information contained within the drive. In this chapter you will learn how to:

- Modify information associated with the initial drive setup.
- View:
 - drive variables,
 - drive parameters,
 - drive status.
- View & Reset Alarm Conditions.
- Request printouts of the information in the drive.
- Perform diagnostic trending.
- Modify the operation of the terminal.

The chapter deals only with the operation of the terminal. Specific references to a particular parameter or variable is only for illustrative purposes. Refer to **Chapter 6 "Parameters and Variable Descriptions"** for information about the actual 'tags' within the drive and their use.

Terminology

Parameter – a memory location within the drive to which data may be written to or read. Setting a parameter (ie. writing to it) will modify how the drive behaves. Prior to using the drive a number of parameters must be set. Additional parameters may be changed while the drive is in use in order to adjust its operation, (ie. the speed could be changed via a parameter).

Variable – a memory location which can only be read. A variable contains real-time data and is used to read the current conditions within the drive, such as running speed.

Tag – A generic reference to either a parameter or a variable.

PanelView 550 – The PanelView 550 is a product marketed by Rockwell Automation consisting of a hardware terminal and a software package, integrated into a single product. The Medium Voltage Drive only uses the hardware portion of the product and has replaced the software package.

Terminal – References to the terminal refer to the product consisting of the PanelView 550 hardware and the unique software contained within it, which allows it to function with the Medium Voltage Drive.

Monitor – An ASCII terminal used by service technicians to connect directly to the Drive Control Boards via an RS232 link.

Editing Field – An area of a screen which is displayed in reverse video. When the field is in this state, data may be entered into it via the keypad.

Operation – A task which is to be performed. In order to complete the task, a number of screens may be involved. Ie. selecting a parameter is an operation which requires at minimum two screens. This operation itself is an operation of modifying a parameter.

EEPROM – Electrically Erasable Programmable Read Only Memory. This is memory which is not affected by loss of power. It is used for long term storage of data such as parameters.

Flash – A type of memory technology which will indefinitely store information and is unaffected by power loss. It is used for storage of firmware, parameters and data files.

PCMCIA – A standard for flash memory cards. Personal Computer Memory Card International Association.

Overview

The terminal used on the Bulletin 1557 Medium Voltage Drive is that of the PanelView 550 (Figure 1). This terminal however does not behave as a PanelView, as only the hardware for the terminal has been utilized. The PanelView software has been replaced with unique software to tailor it to the requirements of the Medium Voltage Drive.

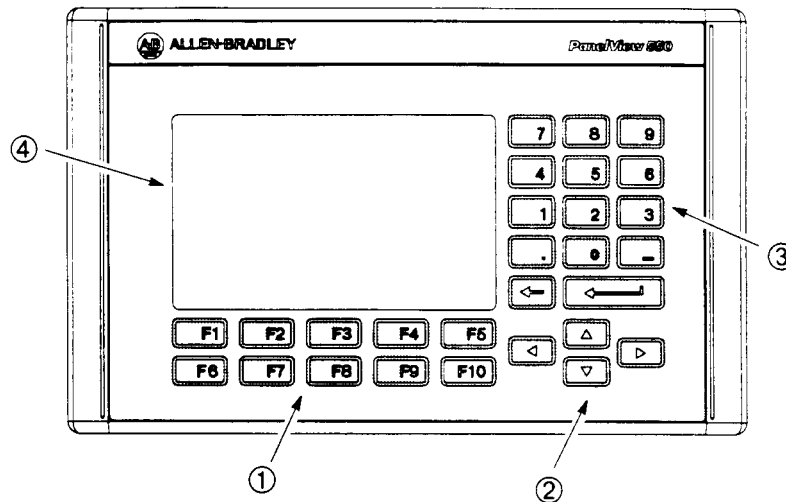


Figure 1 – MVD Display Terminal

Keypad

The keypad of the terminal consists of two rows of five functions keys (item 1 of Figure 1) located below the terminal's display area (item 4 of Figure 1). In the lower right corner of the terminal are four keys which will be referred to as the cursor keys (item 2 of Figure 1). Above the cursor keys are data entry keys consisting of the numeric values 0-9, a decimal point (.), a negative (-), a backspace key and a data entry key (item 3 of Figure 1).

All keys are of a membrane type. The key is executed upon release.

Function (Softkeys) Keys

Along the bottom of the display area is one or two rows of 'Softkeys'. These 'Softkeys' represent the physical function keys. The function of the actual keys will vary between displays. The bottom row of keys (ie. F6-F10) is always shown. The upper row is shown only if they are required for keys (F2-F5). Thus a single row of 'Softkeys' always refers to the keys F6-F10.

Even though the upper row of Softkeys (ie. F1-F5) may not be shown on some displays, the F1-HELP key is always active. (F2-F5) are only active if shown.

Cursor (Selection) Keys

The cursor keys are normally used to select an item on the display. When an item on the display is selected, that item will be displayed in reverse video. To change the selection, press the key in the desired direction.

On selection screens which have more than one page, the page will automatically change when the cursor is moved beyond the displayed list.

Some displays such as the Utility screen, use these keys to modify the data value. Pressing the [cursor up] and [cursor down] keys will change the value by a fine amount, ie. 1 unit. Using the [cursor left] and [cursor right] keys will change the value by a course amount, ie. 10 units.

For entries requiring a HEX value, the keys (cursor up/down) are used to scroll to the desired HEX value.

All four cursor keys have an auto feature such that after holding the key for 2 seconds, the key will automatically repeat at a rate of 5 'presses' per second.

Data Entry Keys

As the name implies, these keys are used to enter data. Pressing the keys [0] to [9] will enter the corresponding value into the 'editing field'. Pressing the [-] key will change the value to a negative number. Pressing the [.] will allow a fractional value to be entered.

While entering a value, the value may be edited using the [backspace] key. This key will remove the right most digit (or decimal point or negative). The help screen uses the backspace key to return to the previous level of help.

The enter key varies depending on the screen. If you are in the process of a selection operation, the enter key will accept the selection and proceed to a different screen based on the selection in order to complete the operation. If you are in the process of entering data, the enter key will accept the edited data.

What is a Screen?

The terminal uses menu driven screens to perform various operations on the drive. You can think of a screen as a window or template, overlaying data from the drive. The terminal combines a screen with the drive data, to formulate what you see on the display area of the terminal. Individual screens display a particular type of data and allows selected operations to be performed on this data. A number of different screens may be used while performing a single operation.

Components

Although the data displayed on any particular screen will vary, the general makeup of a screen is the same for all. Figure 2 shows a typical screen.

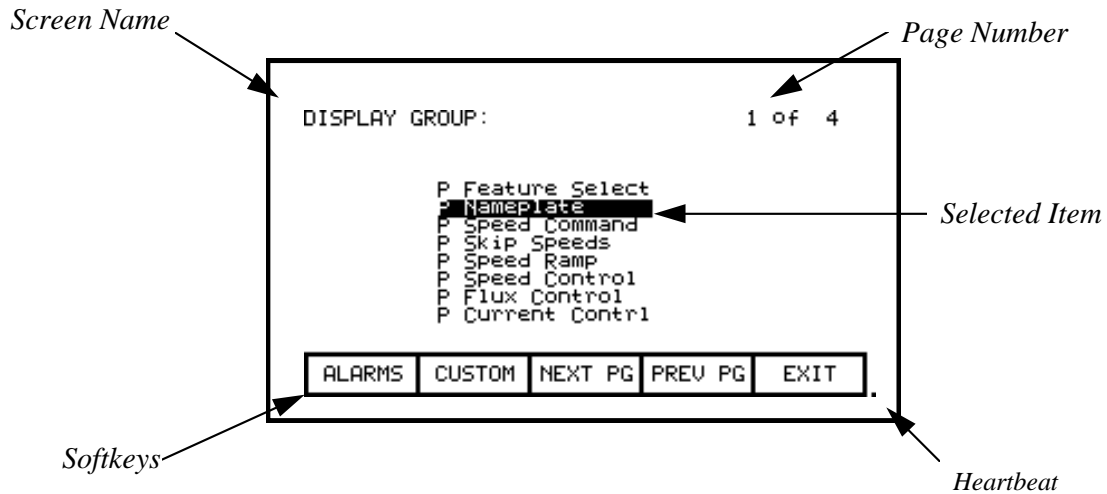


Figure 2 – Screen Components

The upper left hand corner contains the name of the screen (ie. DISPLAY GROUP:). Knowing the name of the screen will assist you in the orientation of the menu system. On some screens to the right of the screen name, will be the name of the selected item from the previous screen as shown in Figure 3.

Some screens have more than one page associated with them. The current page number and the number of pages which make up the data currently being displayed on the screen is shown in the upper right hand corner, (ie. showing page 1 of 3 pages).

Along the bottom of the screen are one or two rows of 'Softkeys' which represent the assignment to the actual function keys. In Figure 2, Softkeys F6-F10 are shown. Pressing F8 will display the next page of data.

In the very lower right-hand corner is a small dot. This dot indicates the healthy state of the terminal. Under normal conditions this dot will flash at a rate of .5 Hz. During communication errors, the dot will flash at a rate of .1 Hz.

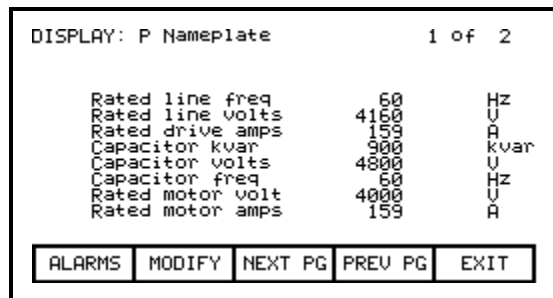


Figure 3 – Screen Name & Item

The remainder of the screen shows the data from the drive. The presentation of the data is dependent on the screen. Screens which allow an item to be selected show the current selection in reverse video. An example of this is shown in Figure 2 in which the P_Nameplate group is selected.

Information Windows

Numerous screens require communications with the drive in order to function. At times, the duration of this activity will be noticeable to you. During this activity, a special 'window' is used within the current screen to inform you of this activity. The time required for the activity will vary.

Accessing/Writing to Drive

The terminal when first powered up, knows very little about the information in the drive. As each screen is activated, the terminal requests information from the drive which it will store within the terminal for future reference. When the terminal requests information from the drive, a window is used to display a message "Accessing Drive ...". During this time, the terminal will not respond to any user input, until the task at hand is completed. You will notice that subsequent activation of the same screen for the same data will be much quicker since the terminal already has most or all of its required information.

You can selectively choose to download the complete database to the terminal on command, thus eliminating the initial access delays. If uninterrupted, the terminal will automatically download the database on powerup, or during periods of inactivity. Refer to the section on "Advanced Screen Operations - Database Download".

Some screens require that information be written to the drive. During this task, a window is used to display the message "Writing to Drive ...". During this time, the terminal will not respond to any user input, until the task at hand is completed.

Communication Error

While the terminal is reading or writing to the drive, it is possible for communications to be disrupted for a number of reasons. If this were to occur, a special window is used to inform you of this. During this time, the terminal will not respond to any user input, until the task at hand is completed.

The window for the "Communication Error" can take on two forms. If a window has already been displayed showing "Accessing Drive" or "Writing to Drive", then the communication error message will be added to the window already in use. Some screens constantly read from the drive in order to show real-time data. An example of this is the 'Top Level Menu'. When a communication error occurs on a screen showing real-time data, a window is opened showing a box around the "Communication Error". Two examples of this are shown in figures 4 and 5.

In both cases, once communications has been re-established, the information window will be removed and the terminal will return to normal operation.

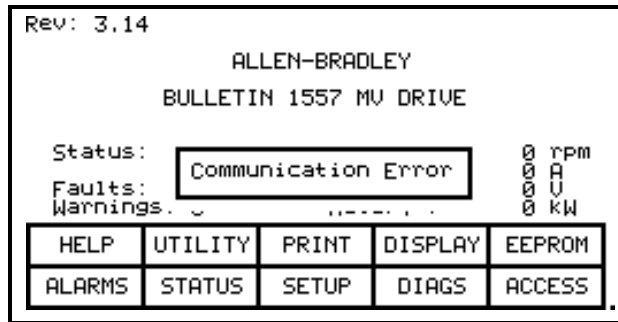


Figure 4 – Communications Error

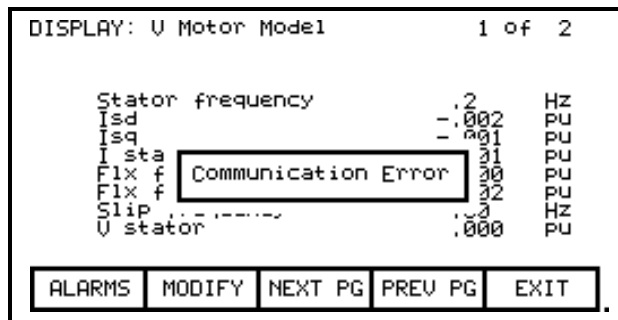


Figure 5 – Communications Error

Language Changing

When the language used by the drive changes, (either via the terminal or an external device), the terminal must do considerable work. The database strings are all invalidated, the character set for the server is changed and all strings used by the terminal are linked to the new language. During this possibly lengthy process, the “Language Changing ...” message is displayed.

General Operation

The operations which can be performed on a screen varies depending on the actual screen being displayed. The majority of the operations are activated by the function keys located along the bottom of the screen. Although the meaning of these keys do change from one screen to the next, there are some functions which are available on most screens and always have the same assignment.

The operations for these latter keys will not be explained within the description of individual screen operations. They are explained here and apply equally to all screens.

F1 - Help

This operation is active on every screen, even if the 'Softkey' is not displayed. Help is context sensitive and will display help which relates to the screen which you are currently viewing.

F6 - Alarms

The F6 'Softkey' will always get you to the Alarm Summary Screen. A new alarm will cause this key to flash in reverse video.

F8 - Next Page

When a screen is capable of displaying data which requires more than one page, this 'Softkey' will be active. The 'Softkey' will increment the page number being viewed.

F9 - Previous Page

When a screen is capable of displaying data which requires more than one page, this 'Softkey' will be active. The 'Softkey' will decrement the page number being viewed.

F10 - Exit

When you are viewing any screen other than the Top Level Menu, this 'Softkey' will return you to the previous screen.

Terminal Powerup Sequence

When the terminal is powered up or reset, it will go through two noticeable operations:

- a) Linking to Drive - during this phase the terminal is establishing communications with the drive communications board. The screen will also show information about the software product contained in the PanelView 550 terminal, such as:
 - software part number and revision level,
 - date and time stamp of program creation.
- b) Obtaining Drive Database - during this phase, the database of information about the drive is obtained from the drive. Obtaining the database at this point in time is optional and may be aborted by pressing any key on the terminal. Obtaining the entire database does however speed up subsequent operations since relevant portions of the database do not have to be obtained. (Without obtaining the entire database, the terminal will access portions of the drive database as required. This slows down the first access to the operation which requires the data. Subsequent operations requiring the same data are not affected). Aborting the download will not affect portions of the database already obtained.

Once the database has been obtained or aborted, the Top Level Menu is displayed.

Top Level Menu

This screen (Figure 6) represents the main menu from which all other screens (and the operations which they perform) are activated. To activate an operation, simply press the function key corresponding to the 'Softkey' shown on the screen. A screen for that operation will be displayed. Refer to the section entitled "How To:" for information about the various operations which may be performed.

The screen identifies the drive product to which the terminal is attached and its overall state of operation. Four digital meters show four selected variables located in the drive. The number of faults and alarms currently active is shown respectively.

The status of the drive will show one of the following:

NOT READY	- drive is not ready to start.
READY	- drive will start when commanded.
FORWARD	- drive is running in the forward direction.
REVERSE	- drive is running in the reverse direction.
WARNING	- drive has a warning.
FAULTED	- the drive is faulted.

Rev: 3.14				
ALLEN-BRADLEY				
BULLETIN 1557 MV DRIVE				
Status: READY	Speed:	0 rpm		
Faults: 0	Current:	0 A		
Warnings: 0	Voltage:	0 V		
	Power:	0 KW		
HELP	UTILITY	PRINT	DISPLAY	EEPROM
ALARMS	STATUS	SETUP	DIAGS	ACCESS

Figure 6 – Top Level Menu

How To:

The following sections describe how to perform the various operations on the drive, using the terminal. Throughout the discussion, a number of screens will be used to achieve the desired operation. In many cases, the same screen will be used for more than one operation, however with possibly different data from the drive.

Throughout the section, you want to focus on how the operation is performed. The terminal will take care of what screens are needed to perform the operation.

Obtain Help

Help is obtained for any screen by pressing the [F1] function key. Figure 7 shows the help screen which is displayed for the Top Level Menu. After the name of the screen (ie. HELP:) is the name of the screen for which help is being accessed. (In this case the name of the Top Level Menu is Rev 3.00). This particular help screen contains three pages. To view page two, press the [F8] key. Page 2 is displayed. To return to page 1 press the [F9] key.

You can return to the original screen from which you asked for help at any time by pressing the [F10] key.

```

HELP: Rev                               1 of 3
* This is the 'Top Level' screen or
'Main Menu'. From this screen, all
other screens may be accessed.
* To access a screen, press the 'soft'
function key which corresponds to the
desired screen. The active function
keys and their purpose are shown on
SOFTKEYS
ALARMS  NEXT PG  PREV PG  EXIT

```

Figure 7 – Typical Help Screen

Related Topics

All of the help screens will have additional topics relating to the help currently being displayed. These topics are highlighted just above the Softkeys. Additional topics are selected via the [cursor left] and [cursor right] keys. Figure 7 shows the additional topic of "SOFTKEYS" selected. To access this information, press the [enter] key.

The help for the additional topic will be displayed as in Figure 8. As with the original help screen, the related topic help may also have related topics.

Press the [backspace] key to return to the previous level of help, (ie. the previous related topic). To exit help completely press [F10] to return to the screen from which help was called.

```

HELP: Rev 3.00                           1 of 7
* F1:  HELP: Calls the help text for
the current screen.
* F2:  UTILITY: Selecting this screen
allows various operations of
the terminal to be viewed and/or
modified, such as:
- setting the clock,
|
ALARMS  NEXT PG  PREV PG  EXIT

```

Figure 8 – Help on Related Topic

Help On Help

The previous sections described how you can access help for a particular screen, by pressing the [F1] key while on that screen. This also applies while in any of the help screens.

Pressing [F1] while in a help screen will give you a help screen describing how to use the help system. An example of a screen giving help on the help system is shown in Figure 9. As with the help screens previously described, the screens will contain related topics.

To return to a previous screen of help information, press the [backspace] key. To return to the screen from which help was originally accessed, press the [F10] key.

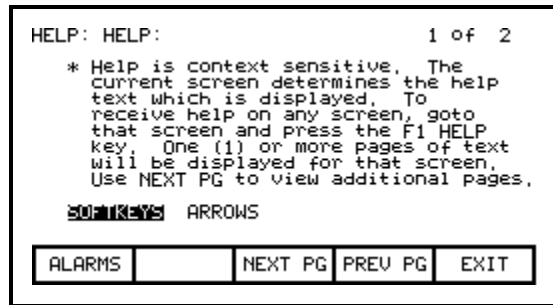


Figure 9 – Help on Help

Modify Terminal Operation (Utility)

The utility operation of screens change the characteristics of the terminal. Within this operation you will:

- Set the clock and calendar
- Change the delay for the display backlight shutoff
- Change the contrast of the display
- Define the meters which will be displayed on the Top Level Menu
- View the revision levels of all software in the drive system.
- Transfer data between the terminal ‘flash’ memory, ‘flash’ memory card and the drive.
- Load a new language module.

You will access the Utility operation from the Top Level Menu by pressing the [F2] key. This results in the display of the screen shown in Figure 10.

In all operations on this screen, the value currently being acted upon is shown in reverse video. Only when the value is in this state, may it be modified.

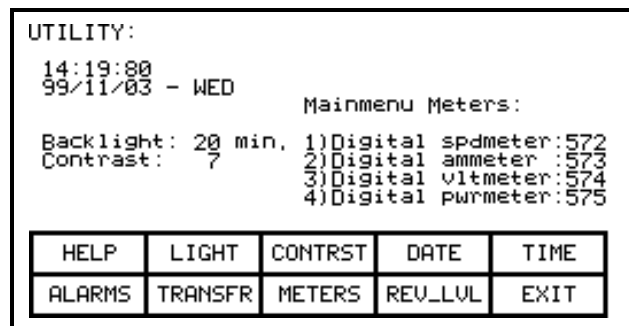


Figure 10 – Utility Operation Screen

Changing Backlight Delay

The display of the terminal is only readable with the aid of a backlight. In order to preserve the life of the lamp which provides this, the back lighting is automatically shut off after a duration of inactivity on the keypad. The backlight is restored by pressing any key. The pressed key will not have any other affect on the terminal when pressed with the backlight off.

To change the duration of the delay press the [F2] key. The current backlight delay will be shown in reverse video. The value can be adjust from 0 to 60 minutes. A value of zero (0) will disable the delay, keeping the light on indefinitely. Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 minute. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 minutes. To abort the change, press the [backspace] key and the setting will return to its original value. To accept the change press the [enter] key. The backlight delay has been saved.

The setting may also be aborted by pressing any of the assigned function keys (other then F1). The function associated with that key will be executed.

Changing Contrast

The contrast controls the horizontal angle to which the display may be viewed. To change the contrast, press the [F3] key. The current value of the contrast will be shown in reverse video. Press the [cursor up] or [cursor down] keys to change the value of the contrast. The screen will change instantly to show the effect of the change. To abort the change, press the [backspace] key and the setting will return to its original value. To accept the change press the [enter] key. The contrast setting has been saved.

The setting may also be aborted by pressing any of the assigned function keys (other then F1). The function associated with that key will be executed.

Setting Time

The clock setting controls the time stamp which the drive uses on the information contained on the alarm summary screen. To change the time, press the [F5] key. The hours position of the clock will be in reverse video. Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 unit. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 units. To change the minutes press the [F5] key again and repeat the procedure. Likewise to change the seconds press the [F5] key again. Each press of the [F5] key will highlight the next position of the clock. The highlighted position may be modified via the cursor keys.

To abort the change, press the [backspace] key and the clock will return to its original time. To accept the change press the [enter] key. The new clock setting has been recorded.

The setting may also be aborted by pressing any of the assigned function keys (other then F1 and F5). The function associated with that key will be executed.

Setting Date

The calendar setting controls the date stamp which the drive uses on the information contained on the alarm summary screen. To change the date, press the [F4] key. The year position of the calendar will be in reverse video. Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 unit. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 units. To change the month press the [F4] key again and repeat the procedure. Likewise to change the day press the [F4] key again. Each press of the [F4] key will highlight the next position of the calendar. The highlighted position may be modified via the cursor keys.

To abort the change, press the [backspace] key and the calendar will return to its original date. To accept the change press the [enter] key. The new calendar setting has been recorded.

The setting may also be aborted by pressing any of the assigned function keys (other than F1 and F4). The function associated with that key will be executed.

The day of the week can not be set by you. The terminal will determine the day of the week based on the date which you set in the calendar.

Selecting Meters

The utility screen (Figure 10) shows the four tags assigned to the four meters on the 'Top Level Menu'. These can be changed by pressing the [F8] key. This displays a new screen (Figure 11) from which the selection and text associated with the meter is changed.

METERS:				
METER1	Speed	:	Digital spdmeter	:572
METER2	Current	:	Digital ammeter	:573
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital pwrmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 11 – Select a Meter

To change the tag attach to a meter, use the [cursor up] and [cursor down] keys to highlight the desired meter and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key in order to gain access and refer to the section entitled "Enter/Modify a Password (Access)".

This will begin the selection process of a tag as described in the section entitled "Select a Parameter/Variable". When you have completed the selection process, the selected tag will be assigned to the meter (ie. Link Inductance). The name of the meter will have been changed to a default string as shown in Figure 12 for meter 2.

METERS:				
METER1	Speed	:	Digital spdmeter	:572
METER2	-Meter2-	:	Link inductance	:27
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital pwrmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 12 – Default Text after Selection

The text consists of 8 characters. This text is displayed on the Top Level Menu along with the value and units of the tag. Select the meter which you wish to modify via the [cursor up] and [cursor down] keys. To modify the text, press the [cursor right] key. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key in order to gain access and refer to the section entitled "Enter/Modify a Password (Access)". The first character position of the string will be in reverse video as shown in Figure 13. Refer to the section entitled "Edit Text". When editing is complete, the screen will appear as in Figure 14.

METERS:				
METER1	Speed	:	Digital spdmeter	:572
METER2	-Meter2-	:	Link inductance	:27
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital pwrmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 13 – Edit the Text

METERS:				
METER1	Speed	:	Digital spdmeter	:572
METER2	-Meter2-	:	Link mH	: Link inductance :27
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital pwrmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 14 – Editing Completed

The terminal contains a default set of meters. This default set is selected by pressing the [F2] key any time the 'Meters' screen is displayed. This results in the default text and tags as shown in Figure 11.

The changes made do not take affect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

The result of selecting the Link Inductance tag for meter 2 (in our example) is shown in Figure 15 after the METERS screen was exited.

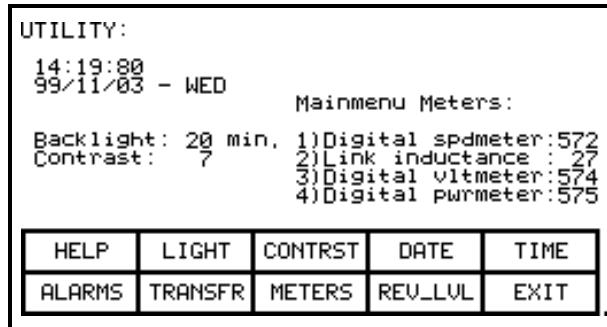


Figure 15 – New Tag for Meter 2

Viewing Revision Levels

For the purpose of maintenance or upgrading of software, the revision levels of all the software contained in the terminal and the drive may be viewed. To access this screen, press the [F9] key.

A screen typical of Figure 16 shows:

- the type of drive,
- a 16 character, user definable string to uniquely identify a drive,
- revision level of the terminal software and its part number,
- revision level of the bootcode contained in the terminal,
- revision level of various boards contained in the drive. These are identified by a name.

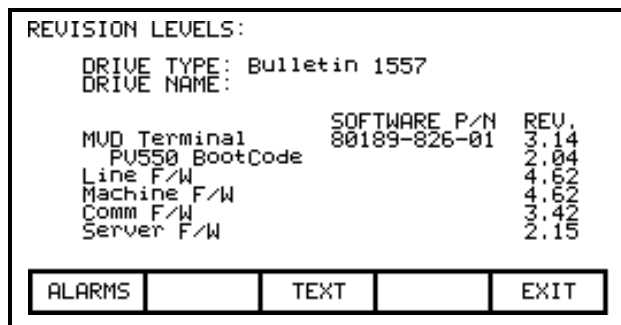


Figure 16 – Revision Level Screen

To modify the user definable text string, press the [F8] key. (If nothing happens then you have not gained the required access to make changes. Exit to the Top Level Menu screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access). A screen typical of Figure 17 will be displayed. To modify the text refer to the section entitled "Edit Text", noting the following exception. When the text has been entered (as in Figure 18) the enter key has no effect. Simply press the exit key [F10] to accept the edited string.

Prior to exiting the screen, the string can be returned to its state upon entry to the screen by pressing the [F7] key.

DRIVE TEXT:				
DRIVE TYPE: Bulletin 1557				
DRIVE NAME: █				
HELP		SET	DELETE	CASE
ALARMS	CANCEL			EXIT

Figure 17 – Edit the Drive Name

DRIVE TEXT:				
DRIVE TYPE: Bulletin 1557				
DRIVE NAME: Boiler Feed #1█				
HELP		SET	DELETE	CASE
ALARMS	CANCEL			EXIT

Figure 18 – Editing Complete

Transfer Data in Memory

The terminal contains long term storage in two forms. Flash memory contained in the terminal is used to store the firmware and optionally language modules and parameters used in the drive. This information can also be stored on a removable flash card which can be taken to another drive.

In order to transfer information from the two forms of memory, press the [F7] key. This displays a new screen (Figure 71) from which all flash memory operations are performed. Refer to the section entitled "Flash Memory Transfers" for instructions on these features.

Select a Parameter/Variable

Various operations require that a parameter or variable be selected. All selection operations are done via one of three methods described in this section. All parameters and variables are organized into groups. Selecting via groups is the default method.

The screens associated with the selection process are called automatically as part of the operation from other screens.

Via Groups

This is the default screen (Figure 19) used in the selection of a parameter or variable. It shows all the groups which are accessible for the operation currently being performed. For example: if you are selecting a parameter, groups containing variables will not be shown. If more than one page of groups exist, press the [F8] and [F9] keys to view the other pages.

Press the [cursor up] or [cursor down] keys to select the desired group, (ie. reverse video the group name). Press the [enter] key. The SELECT screen (Figure 20) is displayed showing the members of the selected group. The name of the selected group currently being displayed is shown after the screen name. Again using the [cursor up] or [cursor down] keys, and if required the [F8] and [F9] keys to change the page, select the desired tag. Press the [enter] key and the selected tag will be used to continue the operation for which the selection process was being used.

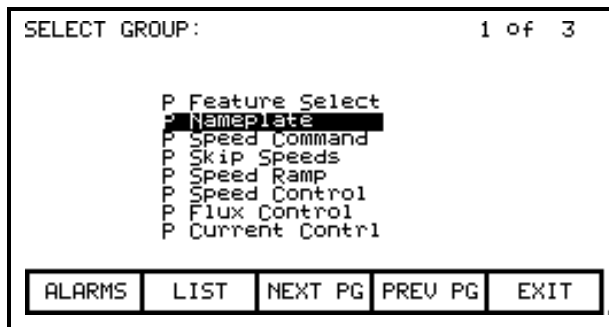


Figure 19 – Selecting a Group

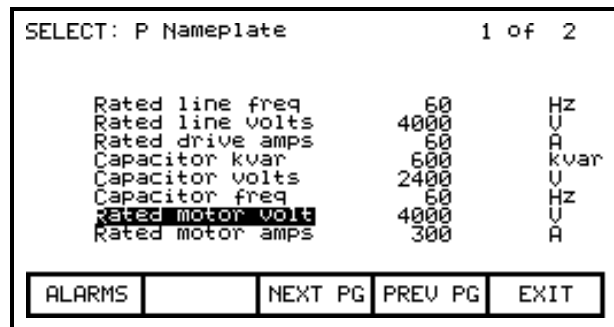


Figure 20 – Selecting a Member of a Group

From the SELECT GROUP screen (Figure 19), the tag can also be selected via its name by pressing the [F7] key.

Via Name

When you know the name of the tag which you wish to select but do not know what group it belongs to or are unsure of the full name, this method of selection may be appropriate.

Selecting via a name is initiated from the SELECT GROUP screen (Figure 19) by pressing the [F7] key. This displays the SELECT LETTER screen shown in Figure 21.

Using the cursor keys, select (ie. reverse video) the letter with which the desired tag starts with. The [cursor up] and [cursor down] keys move vertically within a column, the [cursor left] and [cursor right] key move laterally within the rows. When the appropriate letter has been selected, press the [enter] key.

All tags which begin with that letter, and are appropriate for the operation on which the selection is being performed, will be displayed as in Figure 22. Using the [cursor up] or [cursor down] keys, and if required the [F8] and [F9] keys to change the page, select the desired tag. Press the [enter] key and the selected tag will be used to continue the operation for which the selection process was being used.

From either of these two screens (SELECT LETTER or SELECT LIST) you can return directly to the default selection method via groups by pressing the [F7] key.

SELECT LETTER:				
T I M E R S	L I N E	M O T O R	S P E E D	A M P S
H E L P				C O D E
A L A R M S	G R O U P			E X I T

Figure 21 – Selecting via a Letter

SELECT LIST: 2 of 3				
Rated line freq				
Rated line volts				
Rated motor amps				
Rated motor freq				
Rated motor hp				
Rated motor kw				
Rated motor rpm				
Rated motor volt				
A L A R M S	G R O U P	N E X T P G	P R E V P G	E X I T

Figure 22 – Selecting the Name from a List

From the SELECT LETTER screen (Figure 21) the tag may also be selected via a code by pressing the [F5] key.

Via Code

This method of selecting a tag is initiated from the SELECT LETTER screen (Figure 21) by pressing the [F5] key. It allows you to select the tag, given that you know the tag code associated with the desired tag. Every parameter and variable (ie. tag) has a unique code associated to identify it to devices incapable of making decisions based on a name, such as a PLC for example.

Use the data entry keys [0]-[9] to enter the desired code on the SELECT CODE screen (Figure 23). The entered code may be edited using the [backspace] key. Press the [enter] key.

SELECT CODE:				
Enter Tag Code: 22				
A L A R M S				E X I T

Figure 23 – Enter the Tag Code

The screen will display one of two formats. If the code you entered was valid, it will show the name of the tag associated with the code (Figure 24). This allows you to verify that this was the tag which you intended to select with the code before proceeding. If correct, press the [enter] key. If incorrect, immediately repeat the process by typing in another code. If the tag code was not valid, a message indicating such is displayed as in Figure 25.

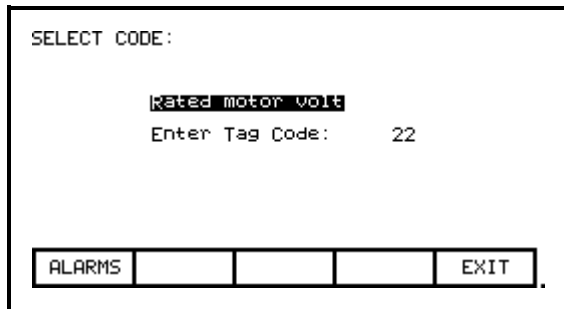


Figure 24 – Valid Tag Code

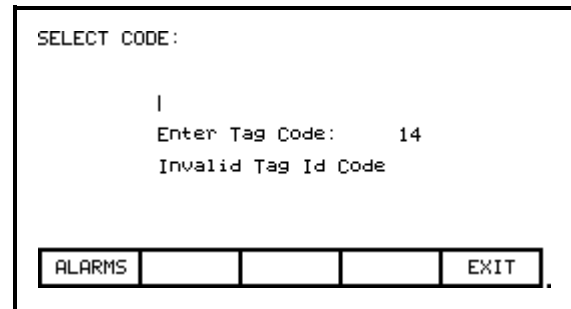


Figure 25 – Invalid Tag Code

When the [enter] key is pressed for a valid tag code (ie. Figure 24) the selected tag will be used to continue the operation for which the selection process was being used if that tag is appropriate for the operation. For example: if you are performing a parameter modification operation, but have selected a variable tag code, you will be unable to exit the screen with this variable. The screen will display this information such as shown in Figure 26. Re-enter a tag code for a parameter or press [F10] to return to the previous screen without making a selection.

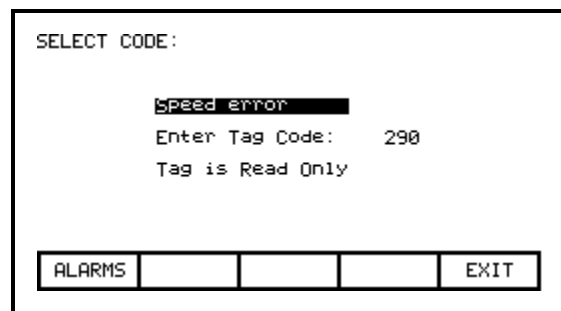


Figure 26 – Selected Tag Inappropriate

Edit Text

Various operations require a text string to be entered. Operations requiring this are:

- setting external faults,
- adding text to selected Top Level Menu meters,
- identifying the drive with a text string,
- entering a filename.

The terminal's keypad does not contain any alpha keys to allow direct input of the characters. This section will describe the operation for which characters may be entered.

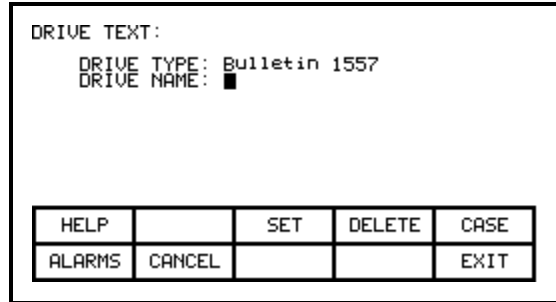


Figure 27 – Typical Text Edit Screen

The screen shown in Figure 27 is typical of all screens using the edit text operation. All screens have the F3, F4 and F5 keys in common (if applicable). Once in the 'editing field' all operations are performed on the character in reverse video.

Pressing the [cursor left] and [cursor right] keys will move to the next character position in the string. Pressing the [cursor up] and [cursor down] keys will cycle through the characters contained in a set, each time the key is pressed. Note that when the first member of a set is displayed, pressing [cursor down] will wrap around to the last member of the set.

There are four sets of characters available. Press the [F3] key to cycle among the sets. The sets consist of:

- a) the upper case letters A-Z.
- b) the lower case letters a-z.
- c) the numbers 0-9 and the characters '.' and '-'.
- d) the characters: space _ () [] { } < > | @ # \$ % & * ! ^ + = ; : ?

Note: These character set may vary depending on the language selected.

A special set consisting of A-Z,0-9 and the underscore character is used for filenames and can not be selected via the [F3] key or modified by the [F5] key.

When a letter is in the editing field, its case may be changed by pressing the [F5] key.

To delete the entire string (ie. fill it with spaces), press the [F4] key.

To abort the changes to the string being edited press the [backspace] key. This will restore the string to its contents when the screen was first entered.

The editing operation is completed by pressing the [enter] key. Changes are not permanently made until the screen is exited via the [F10] key.

Note: The characters entered may only be valid for the currently selected language. Any characters used which are unique for a given language (ie. other than the four sets defined above) can only be meaningfully displayed in the selected language, because other languages do not contain the appropriate display characters.

Configure the Drive

In order to tailor the drive to your motor and application, a number of elements must be defined in the drive. The section describes how you will set or 'configure' these elements of the drive, via this terminal. You will learn how to:

- Change a parameter setting.
- Assign a variable or parameter to an Analog Port.
- Selectively enable or disable (ie. Mask) certain faults.
- Define your own faults attached to external inputs.
- Define the information sent to your optional PLC connection.
- Save and Restore your settings in the drive.
- Select an alternate language (if previously loaded in terminal).

Enter/Modify a Password (Access)

The drive is protected from changes via a password consisting of a number between 0 and 65535. You can view any screen of data for the drive without knowing the password. However to change any piece of data, you must first gain access to it via the password value.

The terminal is always in one of two modes, either Restricted or Unrestricted. Restricted mode means that you are restricted to only viewing the drive operation, you can not make any changes to the drive setup. Unrestricted mode means you have full unrestricted access to any data in the drive the terminal is capable of accessing.

This password value is the key to changing the mode of the drive from restricted to unrestricted.

The screen shown in Figure 28 is accessible from within a number of screens where the unrestricted mode is required for operations such as:

- 1) [F10] key on the Top Level Menu,
- 2) [F8] key on the Modify Parameter screen,
- 3) [F8] key on the Setup Screen,
- 4) [F8] key on the Transfer Screen,
- 5) [F8] key on the Diagnostic Setup screen.

ACCESS:				
Mode: Restricted				
Enter Password: *****				
ALARMS		LOGOUT	CHANGE	EXIT

Figure 28 – Enter the Password

Enter the password value using the data entry keys. The value can be any number between 0 and 65535. As the number is entered via the keys [0]-[9], the value will be shown by a place holder (ie. * in the editing field), as shown in Figure 28. The value may be edited by using the [backspace] key. When the value has been typed in, press the [enter] key. If the correct password was entered, the mode of the terminal will change to Unrestricted as shown in Figure 29. If the incorrect value was entered, the terminal will remain in the current mode.

ACCESS:				
Mode: Unrestricted				
Enter Password:				
ALARMS		LOGOUT	CHANGE	EXIT

Figure 29 – Mode Changed

When the desired operations have been completed, the terminal should be placed back into Restricted mode in order to protect against unauthorized modifications. From this screen press the [F8] key. The mode will change back to Restricted mode as shown in Figure 30.

ACCESS:				
Mode: Restricted				
Enter Password:				
ALARMS		LOGOUT	CHANGE	EXIT

Figure 30 – Mode after Logout

The default value for the password is zero (0), or simply pressing the [enter] key. This value can be changed from the ACCESS screen. Press the [F9] key. The PASSWORD CHANGE screen shown in Figure 31 is displayed.

Enter the current password value via the data keys [0]-[9] and press the [enter] key. As in the ACCESS screen, the entered value is shown via place holders and may be edited with the [backspace] key.

If you entered the correct password, the screen now asks you for the new password. Type in the new password value using the data entry keys [0]-[9] followed by the [enter] key. The screen now asks you to verify the new password. Type in the new password again followed by the [enter] key as shown in Figure 32.



Figure 31 – Enter Existing Password

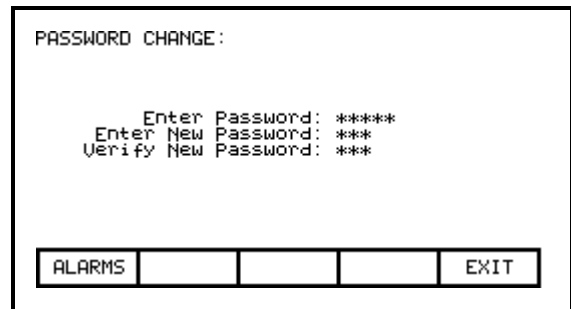


Figure 32 – Enter the new Password

At the end of the operation you will see a status as shown in either Figures 33, 34 or 35 depending on whether you successfully changed the password, incorrectly entered the existing password or incorrectly verified the new password.

If you were not successful in changing the password, simply start over again by typing in the current password value.

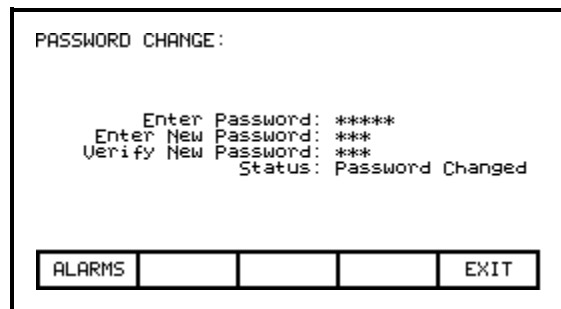


Figure 33 – Successful Password Change

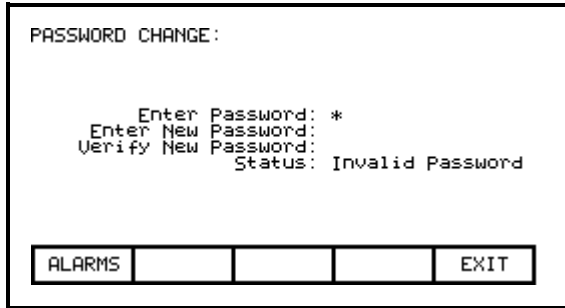


Figure 34 – Incorrect Password Entered

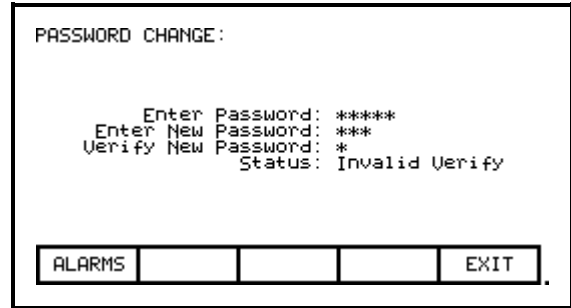


Figure 35 – Invalid New Password Verification

Drive Setup

This section describes how to:

- select an alternate language,
- enter data to a drive parameter
- assign a tag to an analog port,
- enable and disable a fault via a mask,
- assign text to be associated with an external fault input,
- define the tags to be accessible by a PLC.

You will access the "SETUP" screen from the Top Level Menu by pressing the [F8] key. This will result in the screen shown in either Figure 36 or 37.

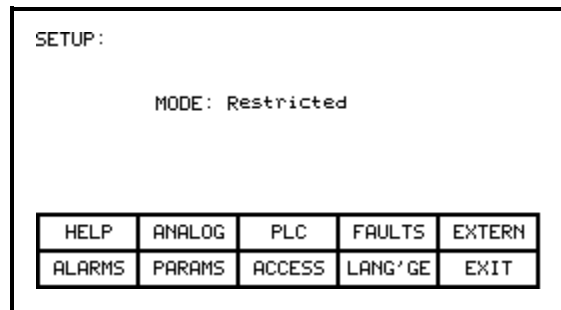


Figure 36 – Restricted Mode

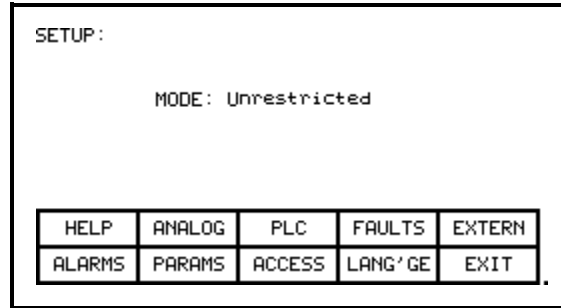


Figure 37 – Unrestricted Mode

Restricted mode means that you are restricted to only viewing the drive setup, you can not make any changes.

Unrestricted mode means you have full unrestricted access to any data in the drive the terminal is capable of accessing. You must be in this mode to perform the setup operations.

At powerup, the terminal is in Restricted mode. If this is the current mode and you wish to change any of the setup data, press the [F8] key now in order to access the Unrestricted mode before proceeding into any of the other setup operations available from this screen. Refer to the section "Enter/Modify a Password (Access)".

Language Selection

The drive is capable of supporting multiple languages. The terminal supports these languages via language modules which must initially be loaded via the flash card (refer to the section "Flash Memory Transfers").

To select an alternate language, press the [F9] key on the SETUP screen. The screen will show all language modules currently loaded as in Figure 38. Associated with each language is a module revision level. Use the [cursor up] and [cursor down] keys to select the desired language and press the [enter] key.

The terminal will switch to the new language selected. It is possible for other devices attached to the drive to request a language change. If this occurs, the terminal will switch to the new language, if the required language module is loaded.

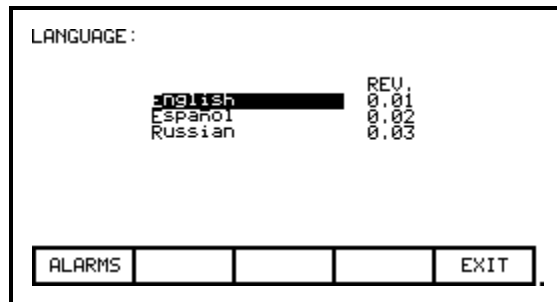


Figure 38 – Language Selection

Modify Parameters

To change a parameter, press the [F7] key on the SETUP screen. This will begin the selection process of a parameter as described in the section entitled "Select a Parameter/Variable". The selection process to change a parameter can also be initiated while displaying the members of a parameter group on the DISPLAY screen (Figure 57) by pressing the [F7] key.

When you successfully have selected a parameter, the MODIFY PARAMETER (Figure 39) screen will be displayed. This screen shows:

- the name of the parameter for which you are making the changes (ie. Rated motor volt).
- the tag code for the parameter, (ie. 22).
- the minimum and maximum allowable limits to which the parameter must be set, (ie. 1000 to 7200).
- the units in which the parameter data is being displayed.
- the actual value of the parameter contained in the drive.

MODIFY PARAMETER: Rated motor volt			
P: 22			
Min:	1000	Urms	
Actual:	4000		
New:	4000		
Max:	7200		
ALARMS	CANCEL	ACCESS	EXIT

Figure 39 – Parameter Data Entry

To be allowed to make changes to the parameter, the terminal must be in the Unrestricted mode. (You will be able to view the screen however, pressing the data entry keys will have no effect). If you are not in the correct mode, press the [F8] key in order to gain access to the parameter. Refer to the section entitled "Enter/Modify a Password (Access)" for further information on the operation to change the mode.

Having gained access, use the data entry keys [0]-[9] to enter the new value. The [-] key can be typed at any time to enter a negative value. The [.] key is used to enter a decimal point for fractional values. The entered new value can be edited by pressing the [backspace] key. This key will delete the right most character (ie. number, decimal point or negative sign) shown on the screen. Press the [enter] key to accept the new value as shown in Figure 40. If the new value you entered is outside the limits defined, the new value will be pegged at the closest limit. For example: if you entered 900 when the minimum value was 1000, the new value will show 1000.

Some data must be entered in HEX. To accomplish this, use the cursor up/down keys to scroll through the values 0-F for the right most digit. To accept the digit and enter to the right of the current digit, press the right cursor key. Press the [Enter] key to accept the value.

The value may be edited the same as a value entered from the numeric keypad.

The new value is not sent to the drive until you exit the screen with the [F10] key. Prior to this you can modify the new value by repeating the above procedure, or you can cancel the change by pressing the [F7] key. The CANCEL operation returns the new value to that of the actual value.

```

MODIFY PARAMETER: Rated motor volt
                                P: 22
Min:                            1000      Urms
Actual:                          4000
New:                             5000
Max:                             7200
ALARMS  CANCEL  ACCESS  [ ]  EXIT

```

Figure 40 – New Parameter Value

Analog Ports

The drive contains a number of external analog ports to which you can assign any variable (or parameter). To setup an analog port, press the [F2] key on the SETUP screen.

This will display a screen as shown in Figure 41. The screen shows the current tags and their tag code which are associated with each of the analog ports. To change the tag attached to a port, use the [cursor up] and [cursor down] keys to highlight the desired port and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access).

```

ANALOG SETUP:                    1 of 2
Analog 1L Idc reference           :321
Analog 2L Idc feedback            :322
Analog 3L Rated motor volt       :22
Analog 4L Speed error             :290
Analog 1M Flux reference          :305
Analog 2M Flux feedback          :306
Analog 3M Isd command             :310
Analog 4M Isq command             :292
ALARMS  CANCEL  NEXT PG  PREV PG  EXIT

```

Figure 41 – Analog Port Setup

This will begin the selection process of a tag as described in the section entitled "Select a Parameter/Variable". When you have completed the selection process, the selected tag will be assigned to the port. To remove an assignment to the highlighted port, press the [delete] (Backspace) key.

The changes made do not take affect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

Fault Masks

A number of the faults within the drive may be selectively enabled or disabled by you. To view or modify the current fault mask settings, press the [F4] key on the SETUP screen.

A typical screen as shown in Figure 42 shows all of the user maskable faults. Associated with each fault is the state of the mask. If OFF, it means the fault is disabled and will not occur. The normal state is ON or enabled.

To change the state of the mask, use the [cursor up] or [cursor down] keys to select the desired fault and press the [enter] key. Each press of the [enter] key will toggle the state of the mask as shown in Figure 43. (If nothing happens, you do not have proper access to the drive. Exit to the SETUP screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access).

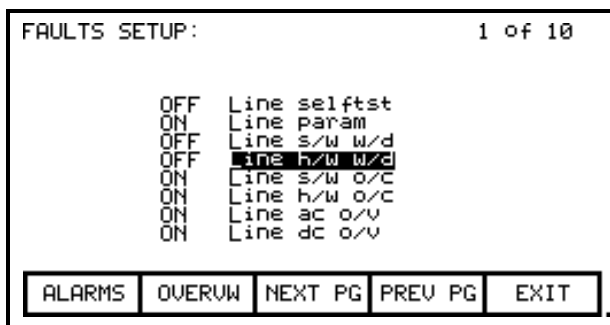


Figure 42 – Typical Fault Mask Setup

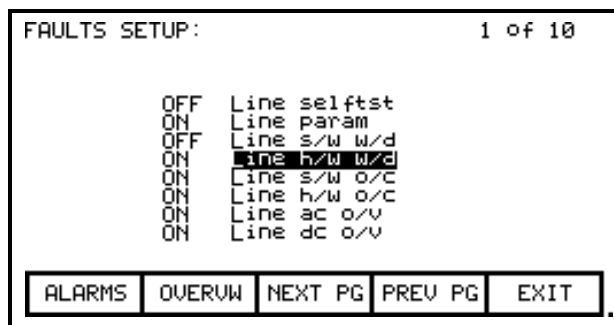


Figure 43 – Toggle Fault Mask State

This screen shows all fault masks regardless of their current state. The fault masks can be viewed according to their state by pressing the [F7] key on the FAULTS SETUP screen. This will display the FAULTS OVERVIEW screen, typical of Figures 44 & 45.

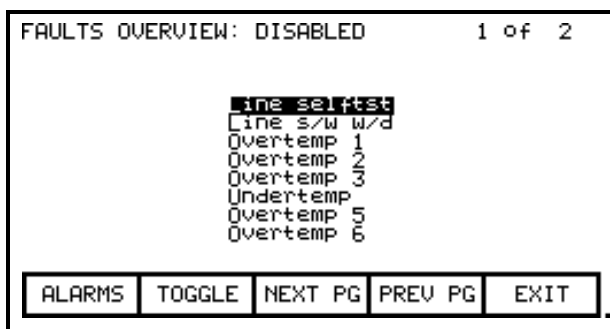


Figure 44 – Disabled Fault Masks

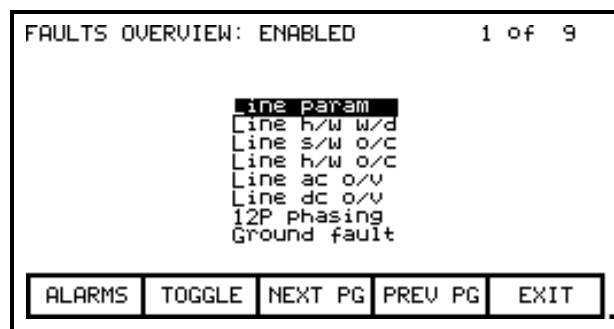


Figure 45 – Enabled Fault Masks

The state of the fault masks which you are currently viewing is defined to the right of the screen name, ie. FAULTS OVERVIEW: DISABLED or FAULTS OVERVIEW: ENABLED. To change the state of fault masks currently displayed, press the [F7]. Each press of the [F7] key will toggle the screen to show the masks in the other state.

To change the state of a mask on the FAULTS OVERVIEW screen, use the [cursor up] and [cursor down] keys to select the desired mask and press the [enter] key. In the example of Figure 44 the Line s/w w/dog is currently disabled and is selected. When [enter] is pressed its mask is enabled, thus removing the fault from this screen as shown in Figure 46. Pressing [F7] toggles the screen to show the enabled faults of which the Line s/w w/dog is one of, Figure 47. (If nothing happens, you do not have proper access to the drive. Exit to the SETUP screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access).

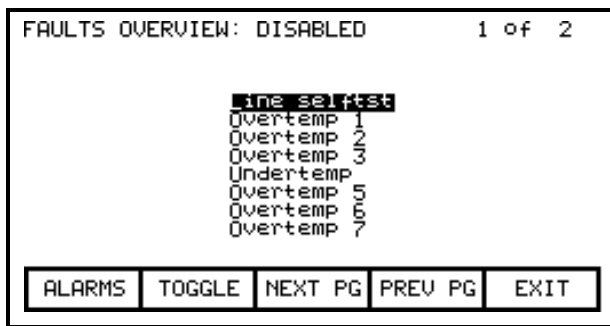


Figure 46 – Fault Mask State Change

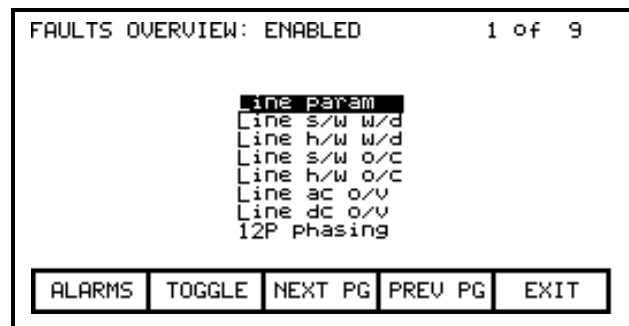


Figure 47 – Result of Fault Mask Change

The changes to the fault masks do not take affect until the screen is exited via the [F10] key, ie. exiting the FAULTS OVERVIEW will change the masks in the drive as will exiting the FAULTS SETUP screen. In our example, exiting the FAULTS OVERVIEW screen and returning to the FAULTS SETUP screen now shows the Line s/w w/dog mask as being ON, Figure 48.

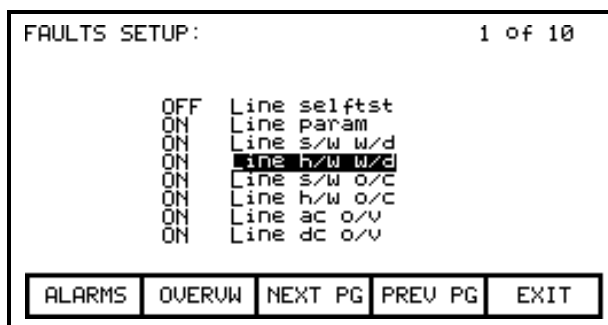


Figure 48 – Result of Fault Mask Change

User Definable Faults

The drive contains a number of external fault inputs. You can custom define the text associated with these inputs, which will be used on the alarm screen and the fault mask screens. To define the text, press the [F5] key on the SETUP screen. A screen typical of Figure 49 will be seen.

EXTERNAL SETUP:		1 of 3		
INPUT 1	Coolant OT			
INPUT 2	Pump1 Fail			
INPUT 3	Pump2 Fail			
INPUT 4	Ext 4			
INPUT 5	Ext 5			
INPUT 6	Ext 6			
HELP		SET	DELETE	CASE
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 49 – External Fault Text Setup

To modify the text attached to a particular fault input, use the [cursor up] and [cursor down] keys to select the desired input. To modify the text, press the [cursor right] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access). The first character position of the string will be in reverse video as shown in Figure 50. Refer to the section entitled "Edit Text". When editing is complete, the screen will appear as in Figure 51.

EXTERNAL SETUP:		1 of 3		
INPUT 1	Coolant OT			
INPUT 2	Pump1 Fail			
INPUT 3	Pump2 Fail			
INPUT 4				
INPUT 5				
INPUT 6				
HELP		SET	DELETE	CASE
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 50 – Edit Text for Input 4

EXTERNAL SETUP:		1 of 3		
INPUT 1	Coolant OT			
INPUT 2	Pump1 Fail			
INPUT 3	Pump2 Fail			
INPUT 4	12 Letters			
INPUT 5				
INPUT 6				
HELP		SET	DELETE	CASE
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 51 – Completion of Editing

The changes made do not take affect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

PLC

The drive can be optionally connected to a PLC via a RIO (Remote Input/Output) adapter. The drive appears to the PLC as a rack of information. The tags which are associated with each of the words within a rack can be defined. To setup the PLC link, press [F3] on the SETUP screen.

This will display a screen as shown in Figure 52 or 53. The PLC setup consists of eight words of input and eight words of output. These are shown on separate screens. The type of PLC word being viewed is defined to the right of the screen name, ie. PLC SETUP: INPUTS or PLC SETUP: OUTPUTS. To switch to the other screen, press the [F8] key. Each press of the [F8] key will toggle the screen to show the other set of words.

The layout of the PLC 'rack' is dependent on the DIP switch settings on the RIO adapter, (refer to **Publication 1203-5.1, "Bulletin 1203 Remote I/O Communications Module"** for information on the RIO adapter and its use). Tags are assigned to rack module locations in pairs. These pairs are referred to as links and consist of two input and two output words. There are a total of four links which can be assigned to the RIO adapter.

The screens show the current tags and their tag code which are associated with each of the links. To change the tag attached to a link, use the [cursor up] and [cursor down] keys to highlight the desired link and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access).

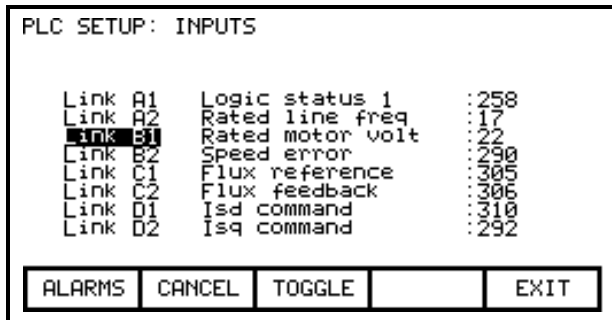


Figure 52 – PLC Inputs Setup Screen

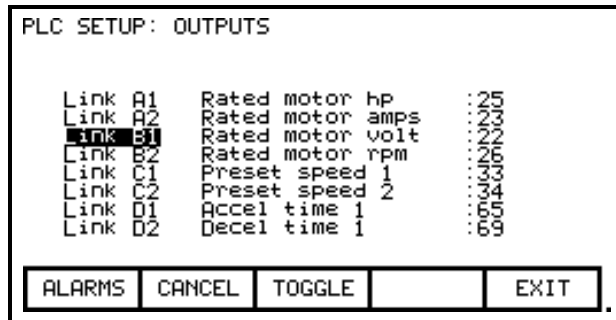


Figure 53 – PLC Outputs Setup Screen

This will begin the selection process of a tag as described in the section entitled "Select a Parameter/Variable". When selecting a tag for the output words, only parameters will be allowed. Both variables and parameters are allowed for the selection of input words. When you have completed the selection process, the selected tag will be assigned to the link. To remove an assignment to the highlighted link, press the [delete] (Backspace) key.

The changes made do not take affect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

Message Prompting

All the changes you made while you were configuring the drive are stored in volatile memory of the drive. This means that when power to the drive is lost, so will be the changes. To permanently store the changes, the contents of the memory must be stored to EEPROM memory.

When you exit a group of screens on which you have changed the drive data, you will be prompted as in figure 54 to save the data. If you wish to save the data, press [F8] 'Yes' and the EEPROM screen (refer to "

Store/Retrieve Drive Configuration (EEPROM)) will be entered. If you wish the data to reside as temporary data in RAM only, press [F9] 'No'. Pressing [F10] Exit will return you to the screen from which you previously exited.

Note that the data can still be saved at a later time by accessing the EEPROM screen directly from the Top Level Menu. Refer to "Store/Retrieve Drive Configuration (EEPROM)".

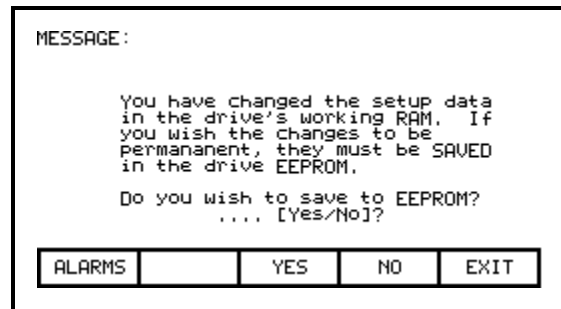


Figure 54 – Message Prompt

Store/Retrieve Drive Configuration (EEPROM)

To access the memory functions, press [F5] on the Top Level Menu. Within this screen it is possible to perform three operations on the memory of the drive. To perform these operations you must have the proper access to the drive. Refer to the section entitled "Enter/Modify a Password (Access)".

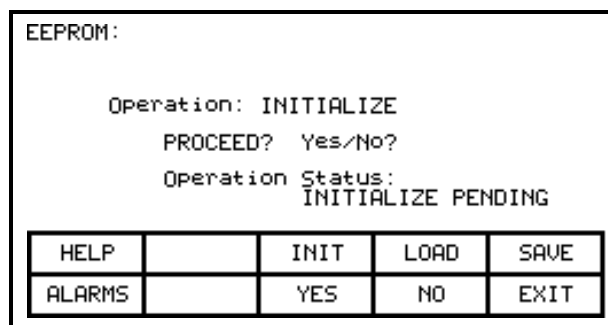


Figure 55 – Initialize the Drive Data

Initialize

The drive contains a default set of parameters and setup information. This can form a basis for configuring the drive. To initialize the drive with the default set of data, press the [F3] key. The screen will appear as in Figure 55, indicating the operation you are about to perform.

The screen then will ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing an initialization will overwrite the data currently in the drive. Previous changes which were saved to EEPROM will not be affected.

Save

The changes which you have made to the drive data must be saved if you do not want to lose the data when the drive is powered off. To save the changes, press the [F5] key. A screen similar to Figure 55 will be shown (except the operation and status will show SAVE TO EEPROM and SAVE PENDING respectively).

To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Saving the data will overwrite the previously stored data in the EEPROM.

Load

The changes which you stored in EEPROM are automatically used each time the drive is powered up. If you make changes to the data in the drive (without saving) and then wish to use the previously stored data, press the [F4] key.

A screen similar to Figure 55 will be shown (except the operation and status will show DOWNLOAD EEPROM and DOWNLOAD PENDING respectively).

To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Loading the data will overwrite the data currently being used by the drive.

Display Variables & Parameters

The variables and the parameters of the drive can be displayed, continually showing the value contained in the drive. From the Top Level Menu, press the [F4] key. The DISPLAY GROUP screen of Figure 56 is displayed.

The screen shows one or more pages of groups which can be displayed. Using the [cursor up] and [cursor down] keys select the group you wish to display and press the [enter] key.

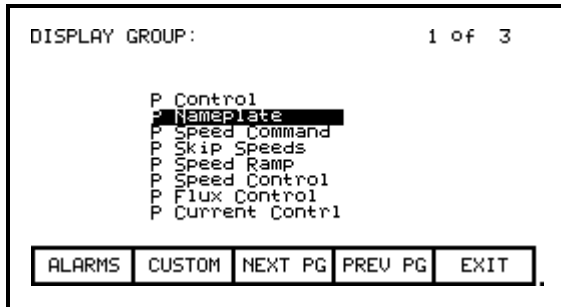


Figure 56 – Selecting a Display Group

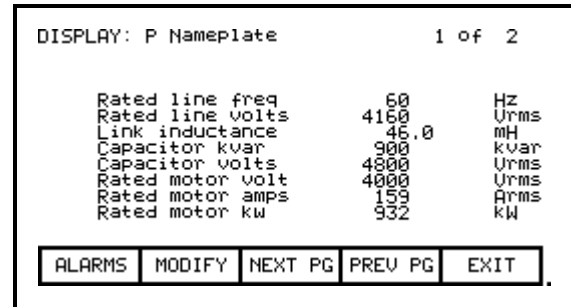


Figure 57 – Displaying a Group

The DISPLAY screen, typical of Figure 57, is displayed. The screen shows the name of the group being displayed to the right of the screen name (ie. P Nameplate). One or more pages of the members in the group are displayed along with the value for this tag in the drive and its unit of measurement. These values are updated from the drive on a continual basis.

From the DISPLAY screen, it is possible to modify a parameter. If the group you are currently viewing contains parameters, press the [F7] key. The terminal then allows you to select the parameter you wish to modify. Refer to the section entitled "

Modify Parameters" for further details.

If you have modified any parameters in the drive, you will be prompted to make the changes permanent. This prompt will occur upon exiting the DISPLAY GROUP screen. Refer to "

Message Prompting" for further details.

Custom Group

From the DISPLAY GROUP screen (Figure 56) you can select a group which you have custom defined by pressing the [F7] key. This custom group contains selected tags from one or more other groups, arranged by you onto a single screen for more convenient viewing, (Figure 58).

To assign a tag to the display, use the [cursor up] and [cursor down] keys to highlight the desired item position and press the [enter] key. This will begin the selection process of a tag as described in the section entitled "Select a Parameter/Variable". When you have completed the selection process, the selected tag will be assigned to the item, as in Figure 59. To remove a tag from the highlighted item, press the [delete] (Backspace) key.

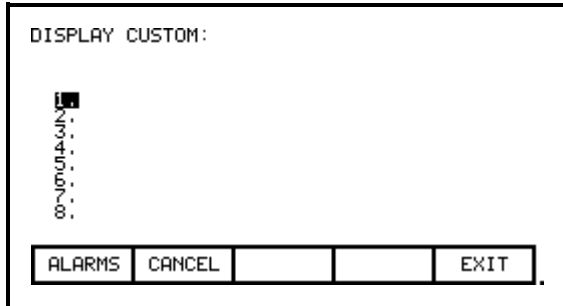


Figure 58 – Custom Display Screen

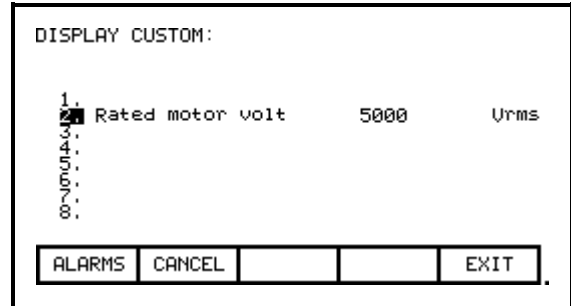


Figure 59 – Assign a Variable/Parameter

The changes take affect immediately, however are not saved until you press [F10] and exit the screen. Any time prior to this you may cancel all the changes made after coming to the screen by pressing the [F7] key.

View Drive Status

The status of the drive is viewed by pressing the [F7] key from the Top Level Menu. This screen, shown in Figure 60, constantly displays the latest status of the drive.

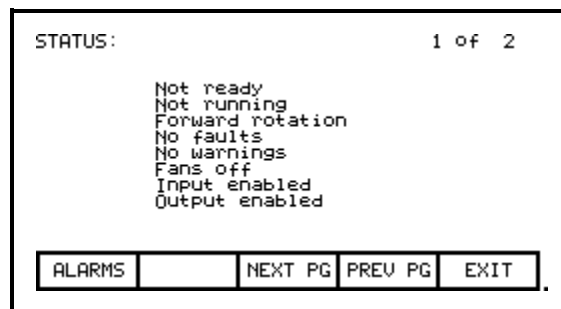


Figure 60 – Status Screen

View & Reset Alarms

All drive faults and warnings are logged to a typical alarm screen as shown in Figure 61. Collectively the faults and warnings are referred to as alarms. When a new alarm occurs, the F6 key of any screen will begin to flash in reverse video. Pressing the [F6] key on any screen will bring you to this screen.

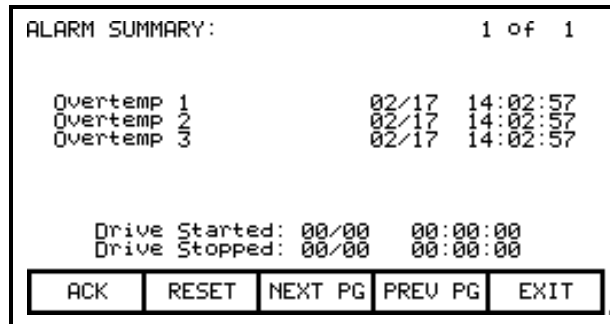


Figure 61 – Typical Alarm Summary Screen

The screen shows all alarms in chronological order which are currently registered in the drive along with a time and date stamp defining when the alarm occurred, (ie. Overtemp1 occurred at 9:06:28 am on March 10). To aid in trouble shooting, a time and date stamp is also provided, indicating the last time the drive was started and stopped normally (ie. not due to an alarm).

To acknowledge the alarm(s), press the [F6] key. This will cause the F6 key to cease flashing and return to normal video. (If a new alarm were to occur, the F6 key would again flash in reverse video).

To reset the alarms and the drive, press the [F7] key. This operation will reset all the faults in the drive, resulting in the displaying of the screen as shown in Figure 62. If some faults still exist, they will return to the screen as new faults.

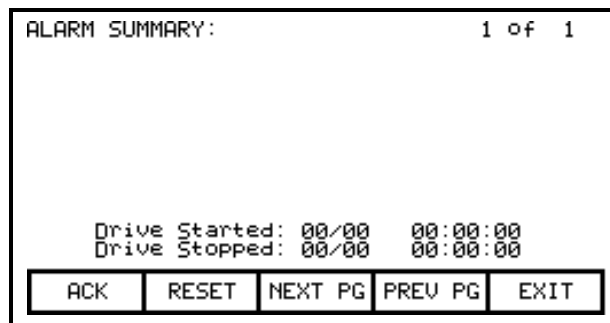


Figure 62 – Reset the Alarm Summary

You should note that it is possible to reset the drive alarms from the 'Monitor' terminal. This action will have the same affect as you pressing the F7 key on this terminal.

Request Printouts

When the drive contains the optional printer, you can obtain hard copies of the data which you are able to view on the terminal. The printouts are requested from the PRINTER screen. Press [F3] while displaying the Top Level Menu.

The screen typical of Figure 63 is displayed. It shows the current status of the printer (A-B part # 80025-290-01) and the type of reports which are available. (Refer to the "Syntest SP401 Thermal Printer User Manual", for information regarding the use of the printer hardware and a description of the various reports available). Using the [cursor up] and [cursor down] keys, select the desired report and press the [enter] key. The report will be sent to the printer.

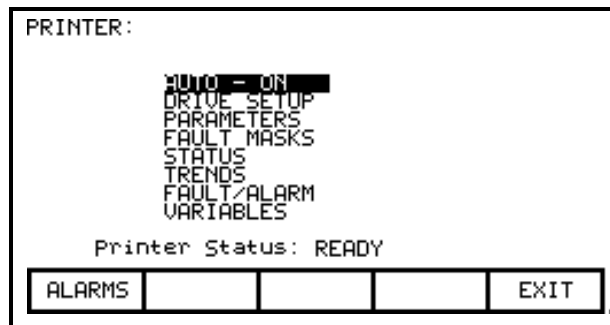


Figure 63 – Typical Printer Screen

The printer can automatically printout the alarms as they occur. This feature is selected as one of the report formats. In the Figure 63, the "AUTO - ON" indicates that this feature is currently enabled. To disable the feature, use the [cursor down] key to select the text and press the [enter] key. The text will change to "AUTO - OFF" (if a printer is attached). The automatic alarm printout feature is now disabled. Pressing the [enter] key again while selected will enable the feature.

Perform Diagnostic Trending

The diagnostic trending operation of screens allows you to capture the relationships of a number of variables over a period of time. Within this operation you will:

- Define the Variables to which the Trend Apply
- Define the Trigger Condition to Begin the Trend
- Define the Sampling Rate and position of the Trigger
- View the results of the Trend

You will access the Diagnostic Trend operation from the Top Level Menu by pressing the [F9] key. This results in the display of the screen shown in Figure 64.



Figure 64 – Diagnostic Trend Main Menu

From this screen, additional screens are accessible to perform the diagnostic trending functions. The screen shows the current status of the trend, (Unprogrammed, Running, Triggered). To define a trend, press the [F8] key to display the setup screen, shown in Figure 65.

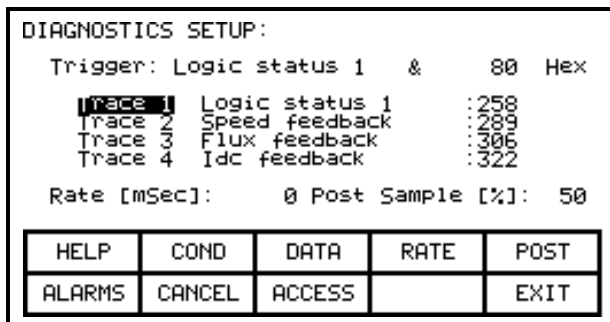


Figure 65 – Diagnostics Setup Screen

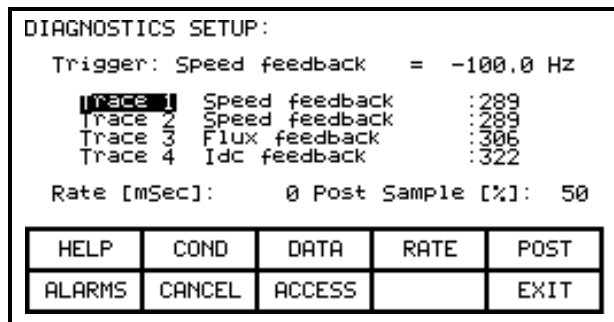


Figure 66 – Assigning a Tag to a Trace

From this screen, the tags to be monitored are assigned to a trace. The tag which you assign to the first trace 'Trace 1' is used as the trigger variable. By default, when assigning a tag to Trace 1, the trigger value (ie. data) will be set to the tag's minimum value and the trigger condition will be unprogrammed. A tag must be assigned to Trace 1 before the trigger value or condition can be set. From this screen you may also set the interval between samples (ie. Rate), and the location of the trigger point within the view buffer. By default, the trigger will occur in the middle of the buffer, however you may change this by indicating the percentage of samples which will follow (ie. Post) the trigger point.

Assigning a Trace

To assign a tag to a trace, use the [cursor up] and [cursor down] keys to highlight the desired trace and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key and refer to the section entitled "Enter/Modify a Password (Access)" to gain access).

This will begin the selection process of a tag as described in the section entitled "Select a Parameter/Variable". When you have completed the selection process, the selected tag will be assigned to the trace, as in Figure 66. To remove a tag from the highlighted trace, press the [delete] (Backspace) key.

Setting the Trigger

Once you have assigned a tag to Trace 1, you may proceed to set the trigger value. Two items of information are required, the trigger condition and the trigger value. These are selected for modification by pressing the [F2] and [F3] keys respectively. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key and refer to the section entitled "Enter/Modify a Password (Access)" to gain access). When the respective field is in reverse video, that field may be modified.

The condition is set to either =, >, <, & by pressing the [cursor up] or [cursor down] keys to scroll through the conditions. Pressing [enter] ends the editing and accepts the shown condition.

The value (data) is set through the use of the numerical keypad. Use the data entry keys [0]-[9] to enter the new value. The [-] key can be typed at any time to enter a negative value. The [.] key is used to enter a decimal point for fractional values. The entered new value can be edited by pressing the [backspace] key. This key will delete the right most character (ie. number, decimal point or negative sign) shown on the screen. Press the [enter] key to accept the new value as shown in Figure 67. If the new value you entered is outside the limits defined, the new value will be pegged at the closest limit. For example: if you entered 900 when the minimum value was 1000, the new value will show 1000.

Some data must be entered in HEX. To accomplish this, use the cursor up/down keys to scroll through the values 0-F for the right most digit. To accept the digit and enter to the right of the current digit, press the right cursor key. Press the [Enter] key to accept the value.

The value may be edited the same as a value entered from the numeric keypad.

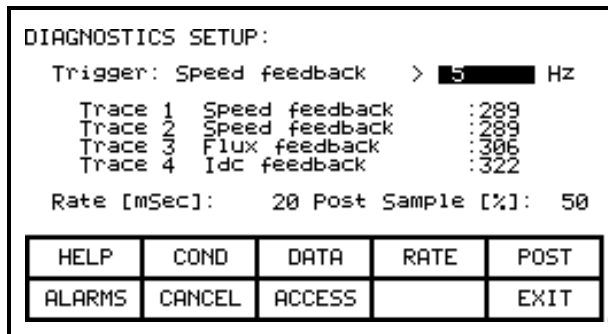


Figure 67 – Editing a Data Field

Defining Sample Rate & Positioning

The rate at which the samples are taken are set by pressing the [F4] key. This data field is then modified in the same manner as the trigger data is entered. Rates can be set from 0 mSec (collect as fast as possible) to 20.000 Seconds.

When samples are collected, part of the buffer will store values prior to the trigger point and the remainder of the buffer will store values after the trigger. Pressing the [F5] key will allow you to set the percentage of the trend buffer, allocated to values collected, after the trigger has occurred. This data field is modified in the same manner as the trigger data is entered.

Starting the Trace

The changes do not take affect, and the trend is not started until you press [F10] and exit the screen. Any time prior to this you may cancel all the changes made after coming to the screen by pressing the [F7] key.

When you exit the screen, the trend is started and the screen such as Figure 68 will show the trigger condition and the status. The trend may also be started by pressing the [F7] key on the DIAGNOSTICS screen.



Figure 68 – Diagnostic Trend Running

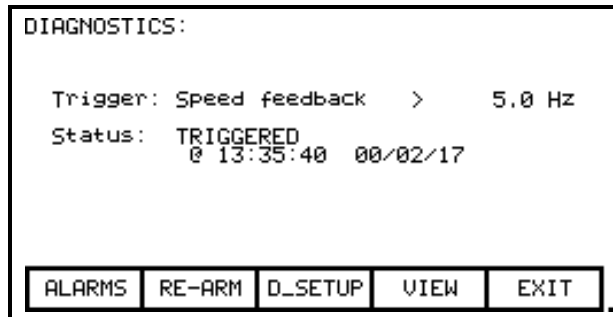


Figure 69 – Diagnostic Trend Tripped

Once the data has been collected, the status will show 'triggered' as in Figure 69. The time and date at which the trigger occurred is displayed. The trend buffers may only be viewed when their status is 'triggered'. To view the trend buffers, press the [F9] key.

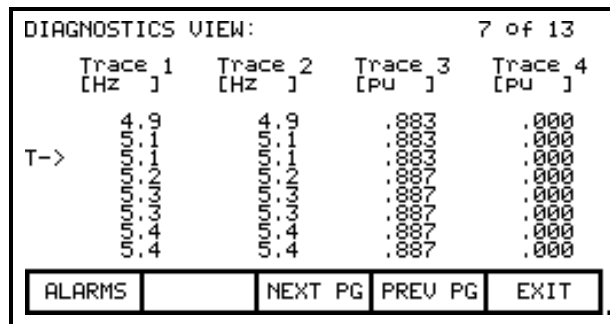


Figure 70 – View the Trend Buffer(s)

A screen such as Figure 70 will be shown. Upon initial entry, the screen will be positioned to the trigger point, shown by the "T ->". To view data either side of the trigger point, press the [F8] and [F9] keys.

Changes made to the diagnostic list setup are not permanent unless they are saved to the EEPROM in the drive. Upon exiting the DIAGNOSTICS screen (figure 68), you will be prompted to save the changes to EEPROM. Refer to the section "Message Prompting" for further details.

Flash Memory Transfers

Flash memory is used to store data in a non-volatile environment, that is it is not lost when power is removed. The terminal contains flash memory in two forms. The first is built into the terminal. This form of flash is used to store the terminal's firmware and parameters from the drive. This information can also be stored on a removable flash memory card.

This second form of flash allows the data from one drive to be physically transferred to another drive for loading. All files on the flash card use a DOS format thus can be read or written by any PC which contains a PCMCIA drive. Flash memory cards which are supported are those that contain the following memory chips from INTEL:

- 28F010
- 28F020
- 28F008SA
- 28F016SA.

These chips are used in the following memory cards available from Rockwell Automation:

- 2711-NM11
- 2711-NM12
- 2711-NM14.

This section describes how you will transfer information between these two forms of flash memory and the drive. You will learn how to:

- Format a flash card.
- Look at the directory of files on a flash card containing the DOS file format.
- Select a program (firmware) from the flash card and load it into the terminal.
- Save the parameters from the drive on the flash card or in the terminal.
- Download parameters to the drive from a flash card or that previously saved in the terminal.
- Load a language module from the flash card.

You will access the Transfer operations from the Utility screen by pressing the [F7] key. This results in the display of the screen shown in Figure 71.

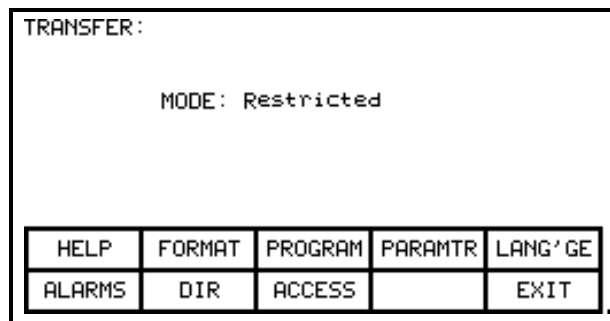


Figure 71 – Transfer Main Menu

From this screen, additional screens are used to perform the various functions involving the flash memory. The screen shows the current mode of operation. Any operations which will alter the contents of the flash memory or of the drive require the drive to be placed into 'Unrestricted' Mode. In 'Restricted' mode you may view the contents of the flash card. To change modes, press the [F8] key. Refer to the section "Enter/Modify a Password (Access)".

Format Flash Card

Flash card files have a characteristic unlike normal DOS files. They can not be modified once written. New files can be added to the card, however they cannot be selectively removed.

When a new flash card is to be used or all the files removed from an existing card, the card must first be formatted. Formatting erases all data on the card and creates a DOS file structure.

To format a card press the [F2] key on the TRANSFER screen. The screen will appear as in Figure 72, indicating the operation you are about to perform and showing the current status of the operation. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access).

TRANSFER: FORMAT:				
FORMAT FLASH CARD				
PROCEED? Yes/No?				
Operation Status:				
FORMAT PENDING				
HELP	FORMAT			
ALARMS		YES	NO	EXIT

Figure 72 – Format the Flash Card

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a format will overwrite all existing data on the flash card.

Formatting can take up to several minutes depending on the card involved. The status will indicate when the formatting is complete or if an error occurred.

Additional cards may be formatted from this screen by pressing the [F2] key.

View a Directory

The directory of a flash card is shown by pressing the [F7] key on the TRANSFER screen. The directory shows the filename and extension, along with a date and time stamp of when the file was created. A screen typical of Figure 73 will be shown.

DIRECTORY:		1 of 1		
Filename:				
350314.FRW		99/07/30	09:10	
FRENCH	.LNG	98/02/25	16:39	
SPANISH	.LNG	97/06/12	13:17	
PUMP	.PAR	99/10/20	11:17	
RUSSIAN	.LNG	97/12/09	09:06	
BOILER	.PAR	00/02/17	13:30	

HELP	EDIT		DELETE	
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 73 – Typical Directory

This DIRECTORY screen is used by any screen or operation which requires a filename to be entered or picked from the directory. It is always obtainable from the [F7] key on any applicable screen.

When the directory is entered from the TRANSFER screen, all files will be shown. When entered from one of the operations screens, only the files which are relevant to the operation being performed will be shown.

Only the root directory of the card is used as sub directories are not supported in the terminal.

Select a filename

When working with existing files on the flash card, it is necessary to pick a file from the directory in order to use in the operation being performed. When the DIRECTORY screen is entered, all files which are relevant to the operation are displayed. The [cursor up] and [cursor down] keys are then used to select the desired file. Pressing [Enter] will select the file and proceed with the operation.

Press the [F10] key to abort the selection operation and return to the previous screen without continuing with the operation.

Enter a filename

When a new file is being created, the DIRECTORY screen is used to enter the new filename. Upon entering the screen all existing files relevant to the operation are shown as shown in Figure 74.

DIRECTORY:		1 of 1		
Filename:				
	PUMP		99/10/20	11:17
	BOILER		00/02/17	13:30
HELP	EDIT		DELETE	
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 74 – Typical File Selection

An existing filename can be used as a basis for the new filename by first selecting that filename. Press the [F2] key. The filename can now be edited. Refer to the section entitled “Edit Text” for further details. When complete, pressing the [Enter] key will proceed with the operation.

Loading Programs (Firmware)

Firmware is the program which is run in the terminal to provide all the functionality described in this manual. Firmware is loaded from the flash card in one of two ways.

- a) If a terminal has a memory card inserted when it is powered up or rebooted, and that card has a valid firmware file with the extension of .FMW, the terminal will automatically load the first .FMW file it encounters on the card.
- b) The user can select from one or more .FMW files on the card and load the selected firmware into the terminal. This is the method which will be described here.

From the TRANSFER screen, press the [F3] key. The terminal will enter the DIRECTORY screen from which an existing firmware filename can be selected or entered. Refer to the sections entitled “Select a filename” and “Enter a filename”. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled “Enter/Modify a Password (Access)” to gain access).

When the filename has been obtained, the TRANSFER: PROGRAM screen such as that in Figure 75 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

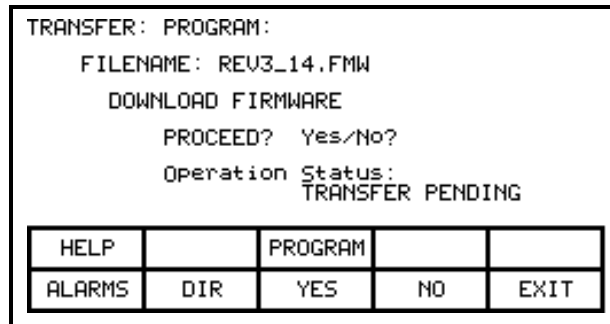


Figure 75 – Load New Firmware

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a DOWNLOAD FIRMWARE operation will overwrite the existing firmware which is currently running.

An aborted download or one which failed prior to starting the download may be restarted by pressing the [F3] key. To select or enter a different filename, press the [F7] key.

Due to the nature of this operation, all other terminal functions will cease during a download. Once the download begins, the terminal's screen will be unable to show any status information. For this reason the two LEDs on the back of the terminal are used as such:

- *Flashing Green* - indicates that all is healthy and the transfer is proceeding.
- *Solid Red* - the transfer has failed. Firmware must be loaded via the method described in a) above. This is achieved by cycling power to the terminal or simultaneously pressing the [cursor left] [cursor right] and [Enter] key at the same time while the flash card is inserted. If more than one firmware file exists on the card, the first one will be loaded and this process will need to be repeated in order to select the firmware file you desire.

When the transfer completes successfully, the new firmware will automatically begin operation. Refer to the section "Terminal Powerup Sequence".

WARNING: *Any time the terminal is powered up with a flash card inserted which contains a valid firmware *.FMW file, the terminal will attempt to load new firmware (note item 'a' above). For this reason, it is not advisable to leave a memory card containing a firmware file in the terminal, after the firmware has been downloaded.*

Parameter Transfers

The parameters which the drive uses are stored within the drive itself. The terminal is used to review and modify these parameters. When a Drive Control Board is changed, it is necessary to re-enter the parameters into the new board. The terminal can simplify this process by reading all the parameters from the old Drive Control Board and storing them either in the terminal or on a flash card. When the new board has been installed, the previously stored parameters are then downloaded to the new board.

The flash card provides an added benefit when more than one drive is using the same set of parameters. Parameters can be entered on the first drive, then uploaded and stored on the flash card. The flash card may then be taken to the remaining drives and the parameters downloaded to those drives.

Note: This feature does not replace the saving of parameters to the Drive EEPROM, refer to section "Store/Retrieve Drive Configuration (EEPROM)". After downloading parameters, they must still be saved within the drive in order to make them permanent.

To transfer parameters, press the [F4] key from the TRANSFER screen. The screen shown in Figure 76 will be displayed. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled "Enter/Modify a Password (Access)" to gain access). Within this screen it is possible to perform four different parameter transfers.

TRANSFER: PARAMETERS:				
HELP	CRD>DRU	MEM>DRU	DRU>CRD	DRU>MEM
ALARMS	DIR	YES	NO	EXIT

Figure 76 – Transfer Parameters Menu

Upload to Terminal

The parameters are read from the drive and stored in the terminal by pressing the [F5] key. The screen will appear as in Figure 77, indicating the operation you are about to perform. The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a "DRIVE TO MEMORY" transfer will overwrite any previous parameters stored within the terminal.

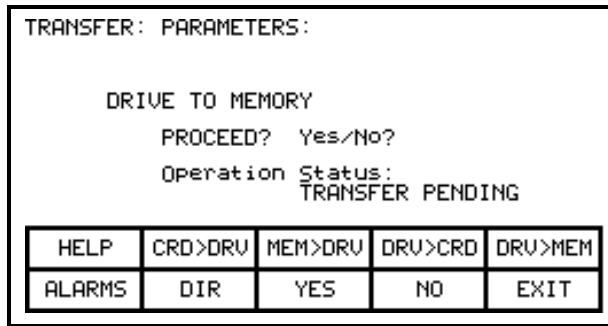


Figure 77 – Transfer Stored Parameters

Download from Terminal

The parameters stored in the terminal are downloaded to the drive by pressing the [F3] key. A screen similar to that shown in Figure 77 will be shown (except the operation will show “MEMORY TO DRIVE”). To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Performing a “MEMORY TO DRIVE” transfer will overwrite the active parameters in the drive. It will not affect the parameters stored within the drive’s EEPROM.

After parameters have been downloaded you will be prompted to make the new parameters downloaded to the drive permanent. Refer to section “Message Prompting” for further details.

Upload to Memory Card

The parameters are read from the drive and stored on a memory card by pressing the [F4] key. The terminal will enter the DIRECTORY screen in which a parameter filename can be entered. Refer to the section entitled “Enter a filename”. When the filename has been obtained, the TRANSFER: PARAMETERS screen such as that in Figure 78 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

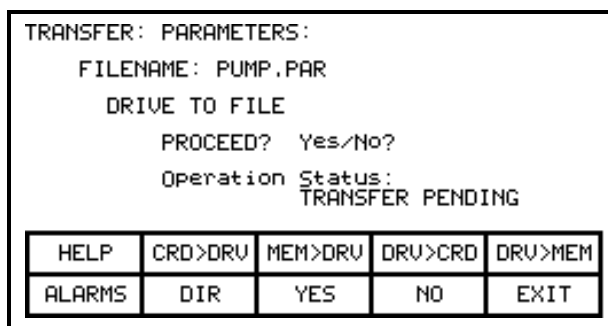


Figure 78 – Transfer File Parameters

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. An aborted transfer or one which failed may be restarted by pressing the [F4] key. To select or enter a different filename, press the [F7] key.

Download from Memory Card

The parameters are read from a memory card and written to the drive by pressing the [F2] key. The terminal will enter the DIRECTORY screen from which an existing parameter filename can be selected or entered. Refer to the sections entitled "Select a filename" and "Enter a filename". When the filename has been obtained, the TRANSFER: PARAMETERS screen similar to that shown in Figure 78 (except the operation will show "FILE TO DRIVE") will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. An aborted transfer or one which failed may be restarted by pressing the [F4] key. To select or enter a different filename, press the [F7] key.

Parameter File Format

The parameter file stored on the flash card is in a DOS file format. This parameter file can be created off-line on a PC using any ASCII text editor and then written to the memory card via a PCMCIA Card Drive.

Information in this section is not needed to operate the terminal. It is required knowledge if you wish to create a parameter file off-line and then download into a drive. The filename must have the extension of *.PAR in order to be recognized as a parameter file. The format of the file is as follows:

a) First Line:

- a revision number followed by a semi-colon (;). Number is not important.
- the date followed by a semi-colon, ie. 01/01/1996. Date is not important.
- the time followed by a semi-colon, ie. 12:01:01. Time is not important.

b) Remaining Lines:

- each line contains one parameter. The line consists of the linear parameter number followed by a semi-colon, and the parameter value followed by a semi-colon. ie.
 - 1;0;
 - 2;0;
 - 5;2;

Loading Language Modules

In order to use a language in the terminal, it must first be loaded into the terminal from the flash card.

From the TRANSFER screen, press the [F5] key. The terminal will enter the DIRECTORY screen from which an existing language module filename can be selected or entered, Figure 79. Refer to the sections entitled “Select a filename” and “Enter a filename”. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled “Enter/Modify a Password (Access)” to gain access).

When the filename has been obtained, the TRANSFER: LANGUAGE screen such as that in Figure 80 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

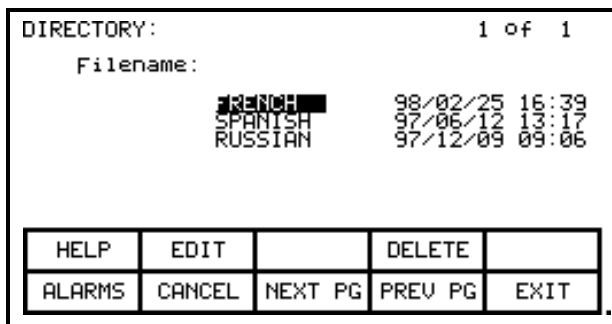


Figure 79 – Language Directory

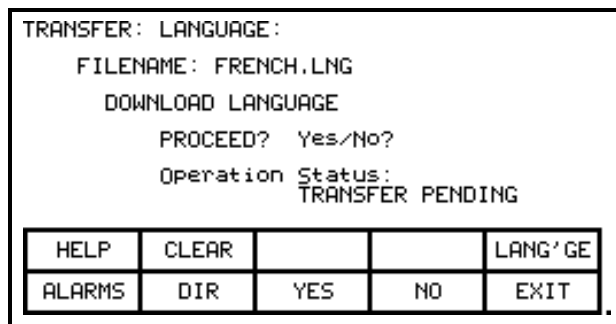


Figure 80 – Transfer Language Module

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. If an attempt to download a language module which already exists is made, the transfer will fail.

In order to download a newer version of a language, all languages in the terminal must first be cleared (this is a characteristic of flash memory) by pressing the [F2] key on the TRANSFER:LANGUAGE screen. The screen as in Figure 81 will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort.

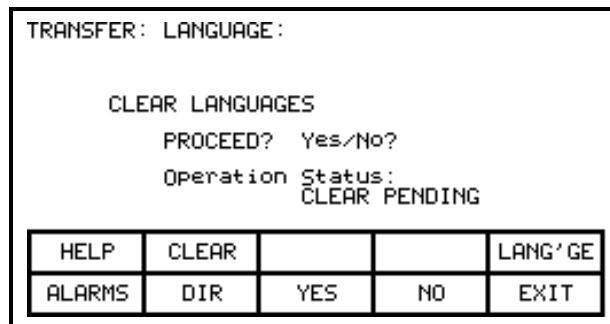


Figure 81 – Clear Languages

An aborted download or one which failed may be restarted by pressing the [F5] key. To select or enter a different filename, press the [F7] key.

Advanced Screen Operations

A number of advanced functions have been incorporated into the terminal. These operations are not required to operate the drive. They are meant as service tools for trained technicians and have been included here only for completeness.

All operations are accessed via a two key sequence.

Communications Statistics

The screen, depicted in Figure 82 shows statistics involving the serial communications between the terminal and the drive as well as the contents of the transmit and receive buffers. It is called from any screen (except the PRINTER screen), by pressing the [F10] key and the [cursor down] key at the same time.

```

COMMUNICATIONS:                               1 of 1
ERRORS:
Parity:    0 Framing:    0 Overrun:    0
Resends:   0 Timeouts:  0 Chksum:    0
Discard:   0 Control:   0 Seqnce:    0
BUFFERS:
TX: Psh0 0; Pop0 0;
   0 10 4 10 6 10 2 7 9A 0
   3 3C 2 1 E3 0 10 4 10 6
RX: Psh0 2; Pop0 2;
   10 4 1 0 0 A1 0 10 4 10
   6 10 2 7 9A 1 0 0 A2 0

```

ALARMS	ANALYZE	RESET		EXIT
--------	---------	-------	--	------

Figure 82 – Communications Statistics & Buffer

The ERRORS show the number of occurrences of a particular error since the last time the counters were reset.

- Parity: number of parity errors in characters received.
- Framing: number of framing errors in the characters received.
- Overrun: number of characters received which were not read prior to accepting the next character.
- Resends: number of times the terminal had to resend data due to a NACK being sent by the drive.
- Timeouts: number of times the terminal did not receive data from the drive within a specified time period.
- Chksum: number of times the terminal detected a checksum error in the data it received from the drive.
- Discard: number of characters discarded by the terminal as they were not what was anticipated.
- Control: number of control codes which did not conform to the anticipated ACK or NACK. The terminal will have assumed ACK, which if wrong will result in a time-out error.
- Seqnce: number of responses from the drive which did not correspond to the last request sent.

To reset the above counters, press the [F8] key.

The BUFFERS show the current contents (in hexadecimal) of the Transmit (TX) and Receive (RX) buffers contained in the terminal. These buffers are circular in nature. The Psh (push) and Pop values indicate the location in the buffer where the next character will be loaded or unloaded respectively. If the values are equal, then the buffer is empty. To aid in viewing the buffer locations, the cursor keys can be used to highlight the buffer contents. The current location of the cursor is shown in reverse video in the mid right screen.

Protocol Analyzer

The protocol analyzer is accessed from the COMMUNICATIONS screen by pressing the [F7] key. The screen shows the data and the relationship of the data exchanged between the terminal and the drive board. This data can be displayed in either one of two formats:

- the data shown in hexadecimal (Figure 83) ,
- the data shown as a mixture (Figure 84) of:
 - a) control characters
 - b) printable ASCII characters
 - c) hexadecimal data.

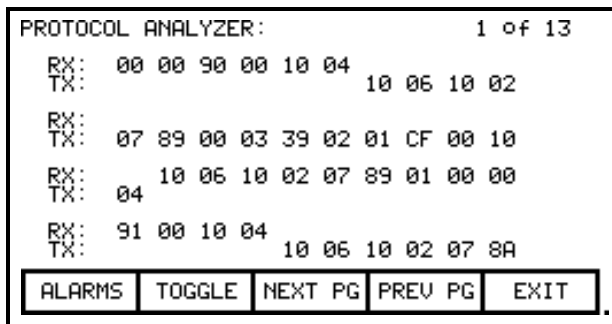


Figure 83 – Hexadecimal Displayed

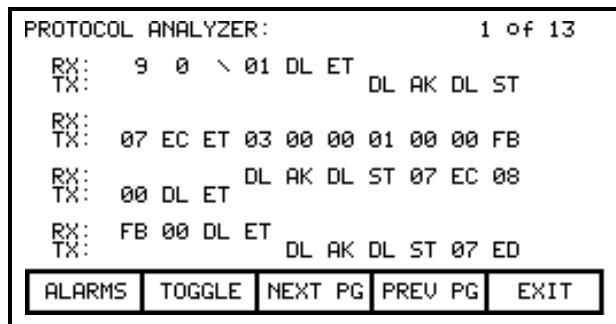


Figure 84 – Mixed Format Displayed

The format of the displayed data is changed by pressing the [F7] key. When data is shown as a mixture, a particular value is displayed based on the priority defined above, (control characters is highest).

The RX row displays data received by the terminal. The TX row displays the data transmitted by the terminal.

Print Screen

The print screen operation allows a screen dump of the terminal's display. This requires the use of a second RS232 port communicating at 600 Baud to an external computer. Special software is required in the computer to receive the data and to interpret the data.

The operation is initiated from any screen by pressing the [F10] key and the [cursor right] key at the same time. The screen will clear and a message will indicate that the screen is being printed as well as the percentage completed. When complete, the original screen will return.

Memory Dump

The memory dump allows any directly accessible memory (ie. memory which is directly addressable and does not require access through a port) to be monitored. It is called from any screen (except the PRINTER screen), by pressing the [F10] key and the [cursor left] key at the same time.

```

MEMORY:
SEGMENT: 0040

0000: AA 55 00 10 00 00 02 0A : .U.....
0008: 31 2E 30 30 00 31 2E 30 : 1.00.1.0
0010: 30 00 31 2E 30 30 00 45 : 0.1.00.E
0018: 6E 67 6C 69 73 68 00 31 : nglisH.1
0020: 2E 30 30 00 40 01 40 00 : .00.0.0.
0028: 44 01 40 00 FF FF 45 01 : 0.0...E.
0030: 40 00 00 00 00 00 06 11 : 0.....
0038: 40 00 AC 00 82 12 40 00 : 0.....0.

[ALARMS] [ADDRESS] [NEXT PG] [PREV PG] [EXIT]

```

Figure 85 – Data Segment Memory Dump

The initial screen, (Figure 85) shows the data segment by default. Each screen shows the segment (in hex) which is being viewed. In the left column is the starting address (in hex) for the row of data. Eight bytes of data are shown in Hex, followed by the equivalent 8 ASCII characters (if relevant). Additional data within the segment is viewed by pressing the [F8] and [F9] keys.

To change the segment and/or offset being viewed, press the [F7] key. A display similar to Figure 86 will be shown. Each successive press of the [F7] key toggles between highlighting the segment and offset value. The highlighted value is the field which is currently being edited.

```

MEMORY:
SEGMENT: 000A New Address: 000A: 18

0000: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0008: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0010: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0018: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0020: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0028: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0030: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b
0038: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b

[ALARMS] [ADDRESS] [NEXT PG] [PREV PG] [EXIT]

```

Figure 86 – Edit the Segment:Offset

The segment:offset address is edited via the numeric keypad and the arrow keys. All values of [0...9] can be entered directly via the numeric keypad. To enter a value of [A...F], the [cursor up] and [cursor down] keys must be used to cycle through the possible values. Note that the value [0...9] can also be entered via this method. Once a digit has been entered via the arrow keys, it must be accepted by means of the [cursor right] key.

The value may be edited via the [cursor left] key which acts as a backspace to remove the last digit entered. The value is accepted by pressing either the [enter] or [F7] key. The edited segment:offset can be aborted by pressing the [delete] key. To accept the segment:offset value entered, press the [enter] key. The screen will show the data at the entered address, as shown in Figure 87.

```

MEMORY:
SEGMENT: 000A
0018: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0020: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0028: AA 55 AA 55 AA 55 AA 55 : .U.U.U.U
0030: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b
0038: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b
0040: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b
0048: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b
0050: 3F 21 5F 62 3F 21 5F 62 : ?!_b?!_b

```

ALARMS	ADDRESS	NEXT PG	PREV PG	EXIT
--------	---------	---------	---------	------

Figure 87 – Data at New Address

Database Download

The database download operation allows the terminal to obtain the majority of the information it requires on your command (instead of as needed). The operation is initiated from any screen by pressing the [F10] key and the [cursor up] key at the same time.

Obtaining the entire drive database is a lengthy process. As the terminal is receiving the database, it will display what portion of the database it is currently obtaining, and the percent done. If the terminal is successful in obtaining the complete database, it will display a message indicating such and wait for a key press from you. If unsuccessful, it will immediately return to the screen from which this call was made. The download may be aborted at any time by pressing any key on the terminal. The portion of the database already obtained will be valid. A subsequent request to download the database, will continue from where the previous download had terminated.

This screen will always return to the screen from which the download was requested.

Terminal Menu Hierarchy Chart

The screens of the terminal are used to form a menu driven system to access the various operations in the drive. The hierarchy of this menu system is shown in Figures 88 and 89.

What does it show?

The chart shows the relationship between screens and a particular operation. It also shows the path to reach a particular screen. This chart does not introduce you to the use of the terminal, however is useful as a reference to the preceding material.

How do you read it?

Each of the boxes represent a screen and contains the screen name. From a particular screen, a downward arrow shows what other screens can be displayed and which function key is required to move to that screen. Pressing exit [F10] on the screen will move you in the opposite direction, returning you to the screen from which you came.

A lateral arrow shows to which screen you can move by pressing the [enter] key while making a selection. Again pressing exit [F10] on the screen will move you in the opposite lateral direction, returning you to the screen from which you came.

Some of the operations have screens in common. These are shown only once on the diagram. Their use is indicated by symbols inserted into a circle. For example: The ACCESS screen is displayed from the MAINMENU by pressing the [F10] key. In this location (marked by an *), the operation of the screens ACCESS and PASSWORD CHANGE are shown in their entirety. These operations are also available from the MODIFY PARAMETER screen and SETUP screens by pressing the [F8] key. At these locations, the operation of screens is represented by the symbol 'P', which represents the same flow as previously defined.

For sake of clarity, the soft function key calls to the HELP operation and the ALARMS screen have not been shown. It is implied that all screens have this ability via the F1 and F6 keys respectively.

Example

As an example of using the chart, we will modify a parameter while displaying it, starting from the Top Level Menu referred to in the chart as the MAINMENU screen. This example assumes you have read the previous sections of this manual. The example will concentrate more on the flow of screens and how it relates to the chart, rather than the actual operations being performed by each screen. The symbols refer to those of the chart. Descriptions of movement, ie. lateral, refer to flow depicted on the chart.

Displaying the MAINMENU, press the [F4] key. The DISPLAY GROUP screen is now shown. Cursor to a parameter group and press the [enter] key. This laterally moves us to the DISPLAY screen. Since you selected a parameter group, pressing the [F7] key takes us into a selection operation (symbol 'D') in which the SELECT screen is displayed. This allows us to use the cursor keys to select the desired parameter.

Pressing the [enter] key laterally moves us to the symbol T which ends the selection process. For this example, the symbol T laterally moves to the symbol M which defines a new process in which the selected parameter can be modified. The MODIFY PARAMETER screen is now displayed.

To change the parameter, you must have the proper access to it. If required press the [F8] key to display the ACCESS screen, as represented by the symbol P. Obtain the access from this screen and press [F10] to exit. This will return you to the MODIFY PARAMETER screen. When you are finished with this screen, press [F10] exit and you will be returned to the SELECT screen (via symbols M and T). Pressing [F10] again will return you to the DISPLAY screen (via the symbol D). Successive presses of the [F10] key will return you to the DISPLAY GROUP and finally to either the MAINMENU or the MESSAGE screen.

If you have changed an data in the drive, the [F10] Exit key will bring up the MESSAGE screen. The message will remind you that the changes made in the drive are only temporary, unless saved to EEPROM. If you desire the data to be temporary, press [F9] 'No' and you will continue onto the MAINMENU. If you press [F8] 'Yes', the EEPROM screen is entered, from which you can save the data. Exiting the EEPROM screen returns you to the MAINMENU. Pressing the [F10] Exit key on the MESSAGE screen will return you to the DISPLAY GROUP screen.

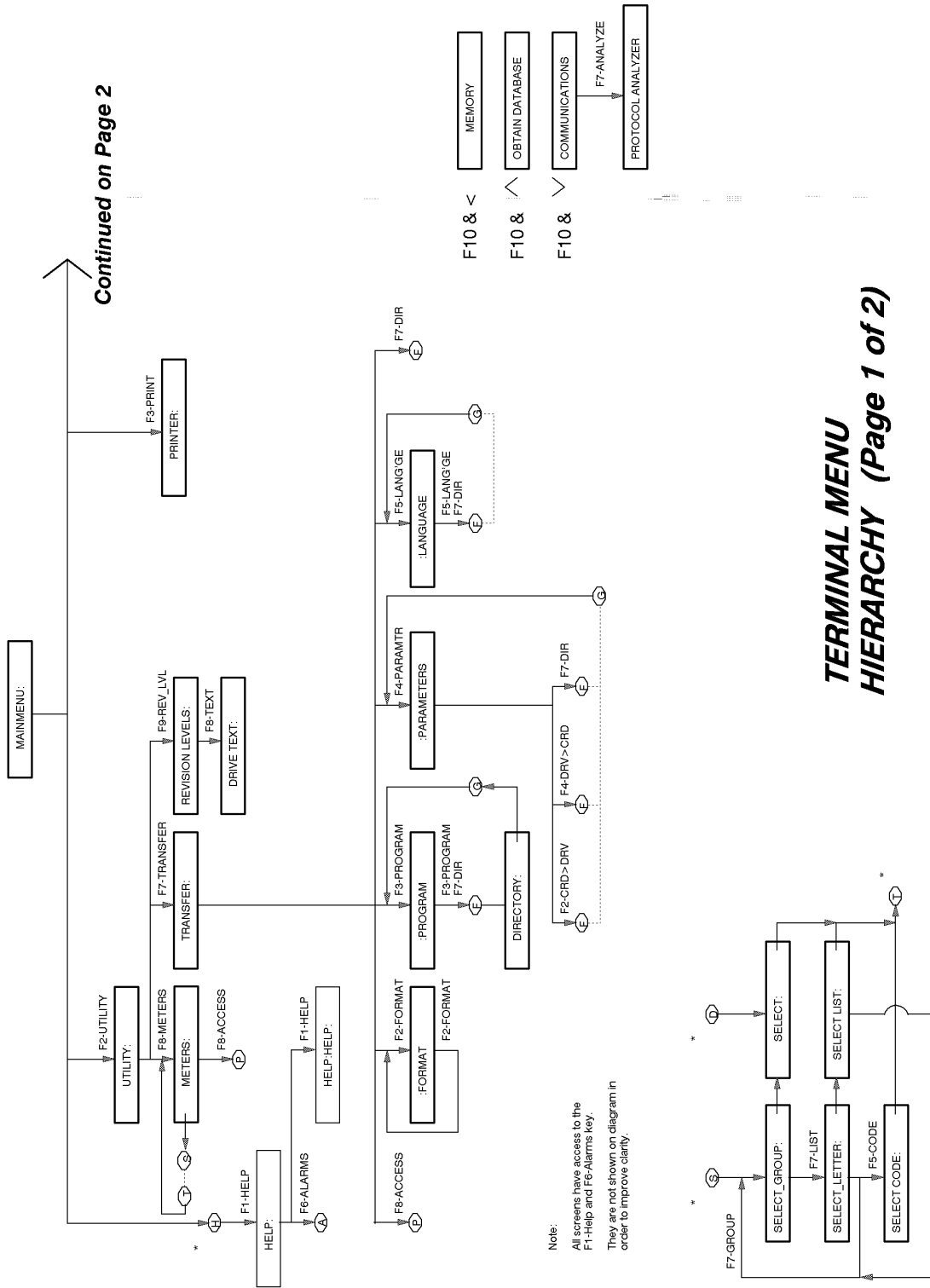
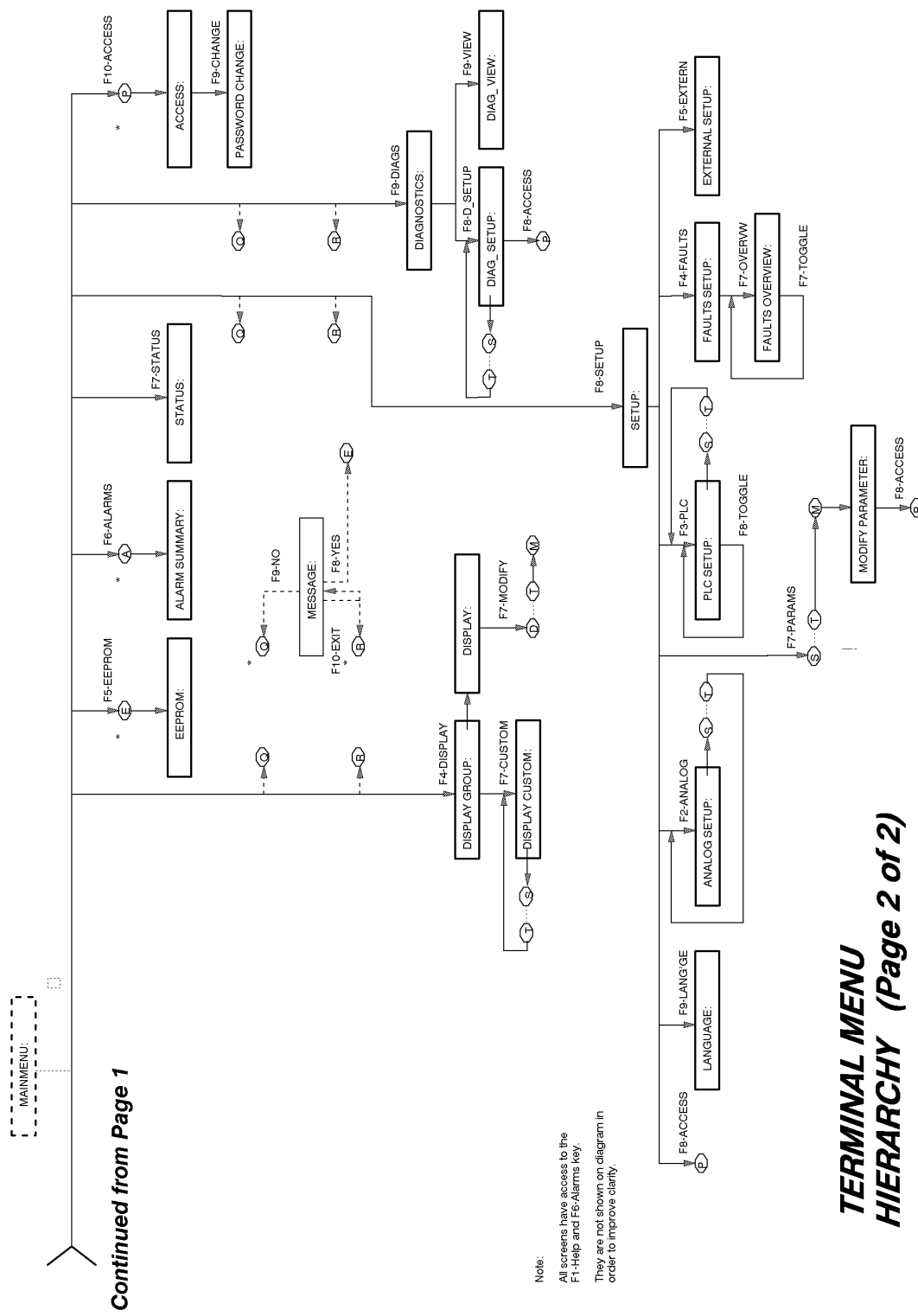


Figure 88 – Menu Hierarchy



Continued from Page 1

Note:
All screens have access to the F1-Help and F6-Alarms key. They are not shown on diagram in order to improve clarity.

TERMINAL MENU HIERARCHY (Page 2 of 2)

Figure 89 – Menu Hierarchy

PanelView 550 PCMCIA Memory Card Installation Data

Description: The memory card slides into the card slot located on the back side of the PanelView terminal. These instructions show how to insert the card in the PanelView terminal.



ATTENTION: The memory card should be kept free from moisture, extreme temperatures, and direct sunlight. Failure to observe this caution could result in damage to the card.



ATTENTION: Do not subject memory card to flexing or extreme shock. Failure to observe this caution could result in damage to the card.

Installing the Memory Card

1. Locate the vertical card slot on the back of the PanelView terminal. See Fig. 1

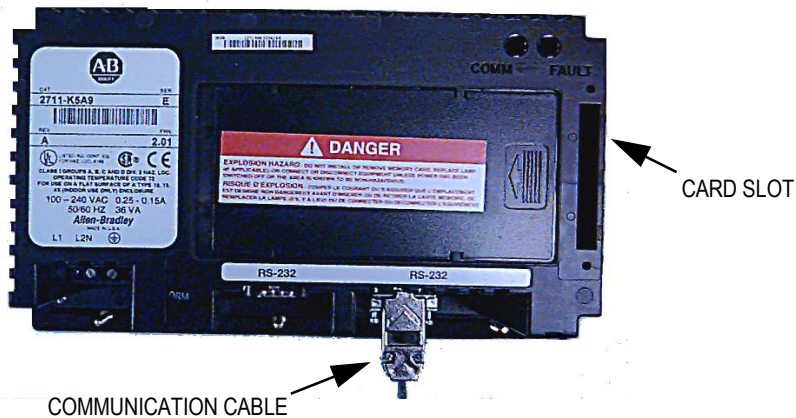
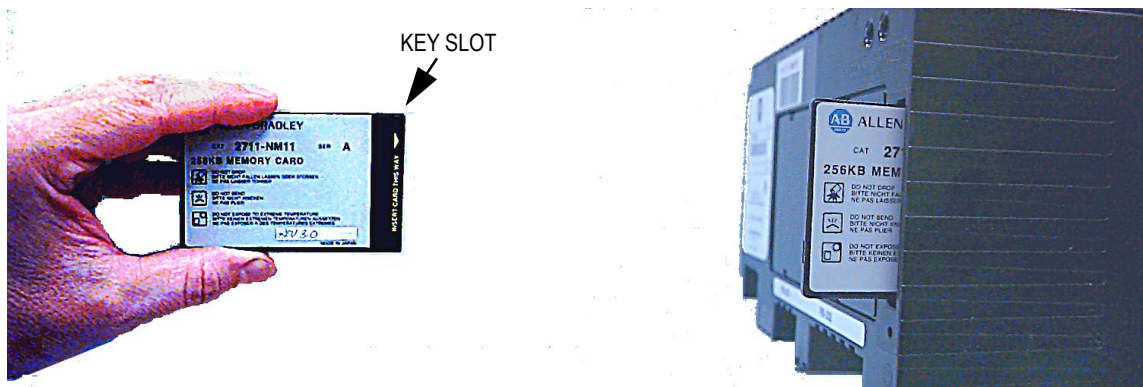


Fig. 1 – Rear view of PanelView

2. Position the card vertically so the key slot is facing the right side of the terminal.



3. Insert the card into the card slot and push until the card is firmly seated.



ATTENTION: Do not force the card into the slot. Forcing the card into the slot may damage the connector pins.

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Safety and Codes



WARNING: The Canadian Electrical Code (CEC), National Electrical Code (NEC), or local codes outline provisions for safely installing electrical equipment. Installation **MUST** comply with specifications regarding wire type, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

Unpacking and Inspection

Before leaving the factory, all drives have been tested both mechanically and electrically. Immediately upon receiving the drive, remove the packing and check for possible shipping damage. Report any damage immediately to the claims office of the common carrier.

After unpacking the material, check the item(s) received against the bill of lading to assure that the nameplate description of each item agrees with the material ordered. Inspect the Bulletin 1557 drive for physical damage, as stated in the Rockwell Automation Conditions of Sale.

IMPORTANT: All claims for breakage and damage whether concealed or obvious must be made to the carrier by the Customer as soon as possible after receipt of the shipment. Rockwell Automation will be glad to render the Customer reasonable assistance in the securing of adjustment for such damage claims.

Remove all packing material, wedges, or braces from within the drive. Operate the contactors and relays manually to assure that they operate freely. If any part of the equipment will not be installed when it is unpacked, it should be stored in a clean, dry place. The storage temperature must be between -40°C (-40°F) and 70°C (185°F) with a maximum humidity of 95%, non-condensing, to guard against damage to temperature sensitive components in the controller.

Transportation and Handling

The 1557 drive is shipped on a wooden skid, which is bolted to the underside of the cabinetry. The drive should remain bolted to the shipping skid until it is delivered to its final installation area. Lifting angles are supplied bolted to the top of the cabinetry. The drive must be kept in an upright position during any handling.

The drive must be transported on a pallet or via use of the lifting beam supplied as part of all 90-inch high cabinets.



CAUTION: Ensure that the load rating of the lifting device is sufficient to safely raise the controller sections. Refer to the packing slip enclosed with shipment for shipping weights.

Round rollers can be used to assist in moving the drive to the installation site. Once at the final site, the pipe rolling technique can be used to place the cabinet in the desired position.



WARNING: Care must be exercised when using either a forklift or the pipe rolling technique for positioning purposes to ensure that the equipment is not scratched, dented or damaged in any manner. Always exercise care to stabilize the drive during handling to guard against tipping and injury to personnel.

NOTE: It cannot be sufficiently stressed how important it is that the customer installation duties are performed correctly. Any errors will certainly cause delays in the Drive Commissioning, if not damage as well.

Never attempt to lift or move the drive by any means other than the methods listed, as structural damage or personal injury could result. The following methods of handling are recommended:

Overhead Lifting:

SEE FIGURE 8.1

1. Attach rigging to the lifting angles on the top of the cabinetry.

CAUTION: Insure that the load rating of the lifting device and rigging is sufficient to safely raise the drive. Refer to shipping weights on the packing slip enclosed with the shipment.

2. Do not pass ropes or cables through the support holes in the lifting angles. Use slings with safety hooks or shackles.
3. Select or adjust the rigging lengths to compensate for an unequal weight distribution of load and maintain the drive in an upright position.
4. To reduce the tension on the rigging and the compressive load on the lifting device, do not allow the angle between the lifting cables/chains and vertical to exceed 45 degrees.

CAUTION: Drives may contain heavy equipment that could be adversely affected by tilting.

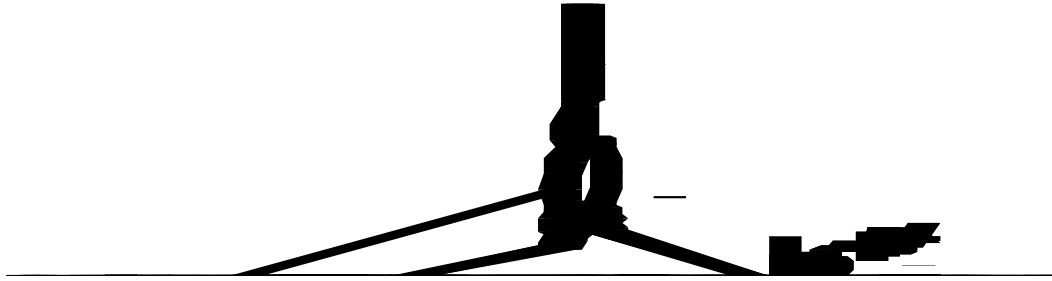


Figure 8.1 – Overhead Lifting

Rod or Pipe Rollers:

SEE FIGURE 8.2

This method is only suitable when there are no inclines and the drive is being moved on one floor level.

1. Boards 2" x 6" or equivalent and at least one foot longer than the drive must be placed under the shipping skid.
2. Carefully ease the shipping platform over the roller pipes until the drive weight is borne on the roller pipes.
3. The drive can be rolled to its designated location. Steady the load to prevent tipping.

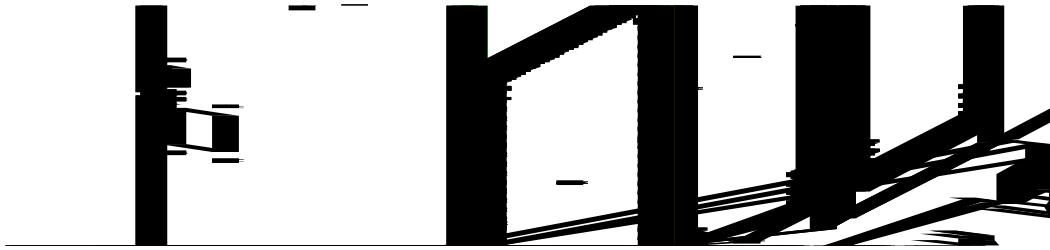


Figure 8.2 – Rod or Pipe Rollers

Fork Lift Trucks:

A single fork lift truck may be used on drives not exceeding ten feet in length if the lift truck has sufficient lifting capacity. Larger drives can be moved with two forklift trucks operating in tandem.

1. Insert forks into openings of shipping skids from the rear of the drive.
2. Carefully balance the drive on the forks because the drives are usually heavier at one side.
3. Use safety straps when handling to steady the drive while moving.

Storage

If it is necessary to store the drive be certain to store in a clean dry dust free area.

Storage temperature should be maintained between -5 and 40 degrees C. If storage temperature fluctuates or if humidity exceeds 85%, space heaters should be used to prevent condensation. The drive should be stored in a heated building having adequate air circulation. The drive must never be stored outdoors.

Installation Site

When selecting the installation site, the following conditions should be considered:

- A) The operating ambient temperature must be between 0°C (32°F) and 40°C (104°F) for NEMA Type 1 enclosures.
- B) The relative humidity must not exceed 95% non-condensing. Excessive humidity can cause corrosion or excessive dirt build-up leading to possible electrical problems.
- C) The equipment must be kept clean. Dust build-up inside the enclosure inhibits proper cooling and decreases the system reliability.

- D) Only persons familiar with the function of the drive should have access to the equipment.
- E) The losses in the drive produce a definite heat dissipation depending on the unit size, which tends to warm the air in the room. Attention must be given to the room ventilation and cooling requirements to ensure that the proper environmental conditions are met.
- F) Operational altitude is 3300 feet (1km) maximum without derating.
- G) The area of the drive should be free of radio frequency interference such as encountered with some welding units. This may cause erroneous fault conditions and shutdown the drive system.
- H) The floor should be level and have provision for the drive anchor bolts. The drive does not require rear access for servicing. The front of the drive requires 44-in. clearance area for service access. Because of forced air cooling, the areas at the top of the drive must be clear and not inhibit airflow.



CAUTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or ambient temperatures above or below the specified temperature range may result in malfunction of the drive.

Mounting

Standard drive cabinet drawings with certified dimension drawings can be obtained by contacting the local Rockwell Automation Sales office. Refer to drawings for mounting requirements.

Installation

Once the drive is at its installation area, the lag bolts, which fasten the shipping skid to the drive, must be removed and the shipping skid discarded.

The drive should be securely fastened in an upright position on a level surface.

After the drive has been placed in its location, the floor mounting bolts may be installed and tightened. (1/2-in. anchor bolts).

Top lifting angles must be removed.

There are several different arrangements of fans for the drive.

When all the fans are already installed in the drive, the ventilation hoods must be installed at each fan after the lifting angles have been removed. Retain the fasteners from the lifting angles.

When "Rotron" fans are to be installed on site, the fan complete with mounting plate must be installed and fan leads connected. The ventilation hood must then be installed.
(see Figure 8.3)

When "Ziehl" fans are to be installed on site, the inlet rings must be installed on the top sheet, then the fan complete with mounting plate and ventilation hood. Leads for the fans are to be routed through the flexible conduit.

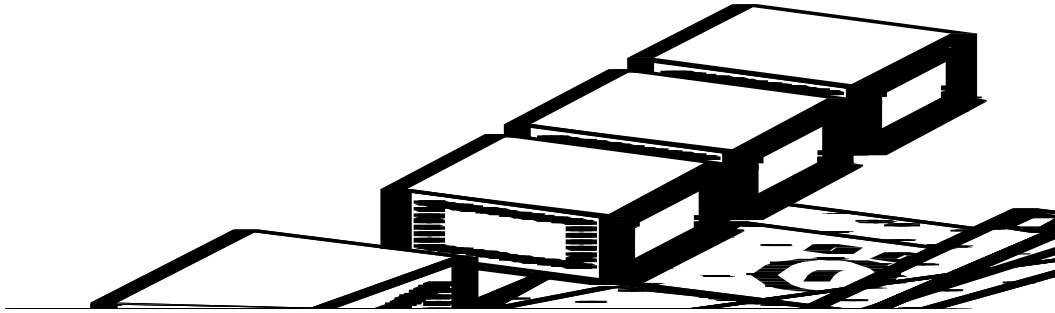


Figure 8.3 – Fan Hood Installation (Rotron Type Fans shown)

Access to the fan terminal blocks is gained by removal of the top plate of the ventilation hood.

After installation of ventilation hoods, replace the hardware from the lifting angles in the appropriate threaded holes at the top of the drive. This prevents dust entering the drive through these holes.

The drive should be securely fastened in an upright position on a level surface to allow proper functioning of the internal devices.

After the drive has been placed in position, the floor mounting bolts may be installed and tightened. The location of these bolts is shown in the customer outline drawings specific to each drive. A typical location of floor mounting bolts is shown in figure 8.4. Floor mounting hardware is to be 1/2" anchor bolts.

The mechanical door interlocks should be tested, if they do not function properly it may be because the installation site is not level. Adjustments may be required.

The mechanical interlock system is designed to prevent:

- (1) Opening of medium voltage compartment doors when the drive-isolating switch is closed.
- (2) Operating the drive-isolating switch with any medium voltage doors open.

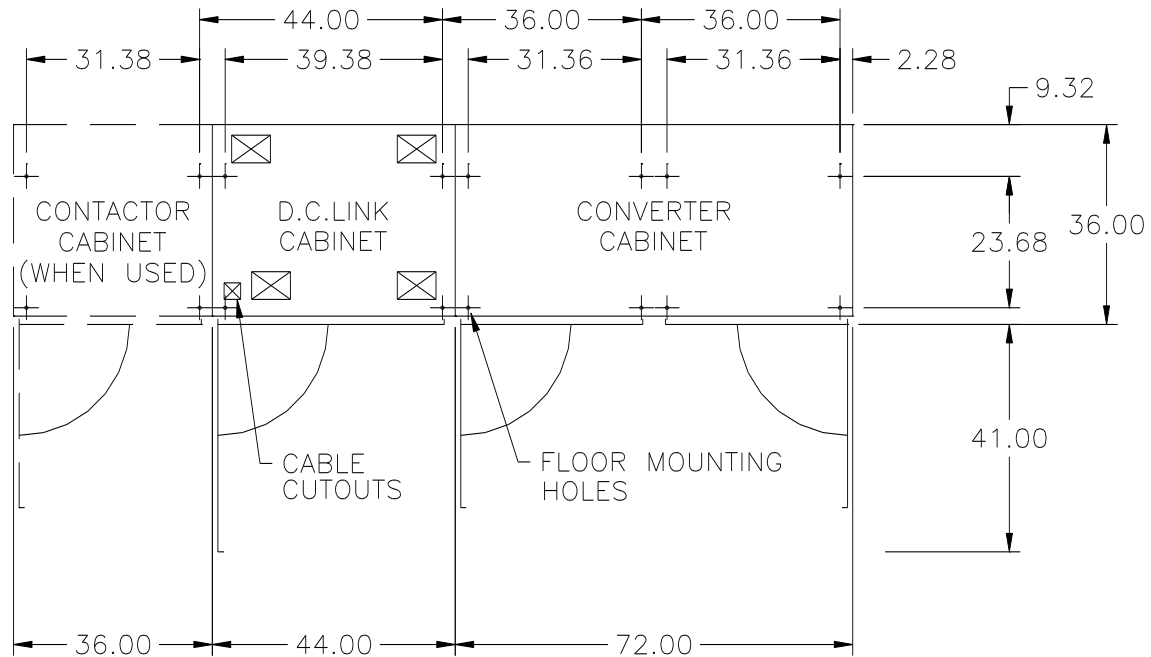


Figure 8.4 – Typical Drive Floor Plan

The drive isolation switch and contactor may be located remotely from the drive, in which case; Kirk key interlocks or their equivalent must be used to interlock the drive and its isolating switch. It is the responsibility of the installer to ensure that all required interlocks are installed and function properly.

Grounding Practices

The purpose of grounding is to:

- A) Provide for safety of Personnel.
- B) Limit dangerous voltages on exposed parts to ground.
- C) To facilitate proper over current device operation under ground fault conditions.
- D) To provide for electrical interference suppression.

IMPORTANT: Generally, grounding should be in accordance with the Canadian Electrical Code (CEC) or National Electrical Code (NEC) and local codes.

Each power feeder from the substation transformer to the drive must be provided with properly sized ground cables. Simply utilizing the conduit or cable armor as a ground is not adequate. The conduit or cable armor and ground wires should be bonded to ground at both ends. Each transformer enclosure and/or frame must be bonded to ground at a minimum of two locations.

NOTE: If a drive isolation transformer is used, the WYE secondary neutral point should not be grounded.

Each AC motor frame must be bonded to grounded building steel within 20 feet of its location and tied to the drive's ground bus via ground wires within the power cables and/or conduit. The conduit or cable armor should be bonded to ground at both ends.

Ground Bus

The drive ground bus is accessible from its cover plates at each end of the drive. It is the responsibility of the installer to ensure that the drive is grounded properly.

Low Voltage Wiring

A low voltage (110 volts/ 60 Hz) power supply is required for drive auxiliary components. Terminal blocks are accessible when the medium voltage door containing the low voltage compartment is in the fully open position. Low voltage wiring is to enter the cabinet through the access openings in the floor or top plates of the cabinet, and routed through the wire duct provided.

Tachometer Connections - The Tachometer wires must be routed in grounded steel conduit for electrical noise suppression. The conduit must be grounded at both ends. Connect the cable shield to the drive isolated ground bus at the drive end ONLY.

Power Connections - The drive requires a three-phase supply and an equipment-grounding conductor to earth ground. A neutral conductor of the three-phase supply is not necessary and is usually not routed to the drive. Three-phase wiring will connect the drive to the motor.

IMPORTANT: The CEC and NEC require that branch circuit protection of the AC line input power to the drive be provided by a circuit breaker or fusible disconnect switch. The standard drive provides this requirement.

IMPORTANT: The control and signal wires should be oriented a distance of at least six (6) inches (150mm) from power cables. Additional noise suppression practices (including separate steel conduits for signal leads, etc.) are recommended. We also recommend that 24V DC Logic wiring NOT exceed 50 feet from the drive.

Power Cabling Access

Access plates are provided on the top and bottom plates of the cabinet. Figure 8.5 shows the typical areas available for cables. Consult the outline drawings of the drive, as locations may change due to specific customer requirements. Incoming cables areas are coded (P) and motor (load) cable areas are coded (L). Low voltage wiring areas are coded (C).

The maximum recommended cable size is one 250 MCM per phase. Cable termination points are accessible from the front of the drive with the medium voltage doors open.

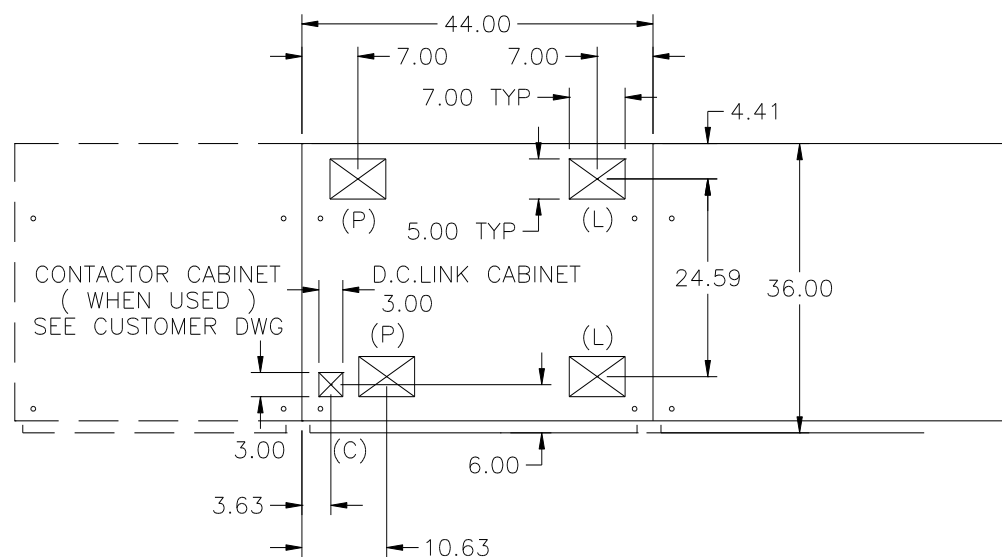


Figure 8.5 – Typical Power Cabling Access (Bottom Entry shown)

POWER WIRING SELECTION

The following tables identify general wire selections that will be encountered when installing the Bulletin 1557 drive system.

General Notes:

Adherence to the following recommended field power cabling insulation levels for Medium Voltage Drives will help to ensure trouble free start-up and operation. The cable insulation level must be increased over that which would be supplied for an Across-the-line application with the same rated line to line voltage.

Either shielded or unshielded cable may be used based on the criteria considered by the distribution system designer.

2400V and 3300 V Medium Voltage Drives

Pulse #	Isolation Transformer or Line Reactor	Cabling Source		Cable Insulation Rating
		From	To	
6, 12	Isolation Transformer	Tx. Secondary or Secondaries	Line side converter (Drive)	5 kV
		Line side converter (Drive)*	Remote DC Link Reactor*	5 kV
		Remote DC Link Reactor*	Machine side converter (Drive)*	5 kV
		Machine side converter (Drive)	Motor	5 kV
		Machine side converter (Drive)*	Remote Motor Filter Capacitors*	5 kV
6	Line Reactor	Power System	Line side converter (Drive) or Input Contactor	5 kV
		Line side converter (Drive)*	Remote DC Link Reactor*	5 kV
		Remote DC Link Reactor*	Machine side converter (Drive)*	5 kV
		Machine side converter (Drive)	Motor	5 kV
		Machine side converter (Drive)*	Remote Motor Filter Capacitors*	5 kV

* These external power connections are only required on the larger horsepower Medium Voltage Drives.

Table 8.6 – Power Wire Selection (2400V and 3300 V)

4160V Medium Voltage Drives

Pulse #	Isolation Transformer or Line Reactor	Cabling Source		Cable Insulation Rating
		From	To	
6, 12, 18	Isolation Transformer	Tx. Secondary or Secondaries	Line side converter (Drive)	8 kV
		Line side converter (Drive)*	Remote DC Link Reactor*	8 kV
		Remote DC Link Reactor*	Machine side converter (Drive)*	5 kV
		Machine side converter (Drive)	Motor	5 kV
		Machine side converter (Drive)*	Remote Motor Filter Capacitors*	5 kV
6	Line Reactor	Power System	Line side converter (Drive) or Input Contactor	5 kV
		Line side converter (Drive)*	Remote DC Link Reactor*	5 kV
		Remote DC Link Reactor*	Machine side converter (Drive)*	8 kV
		Machine side converter (Drive)	Motor	8 kV
		Machine side converter (Drive)*	Remote Motor Filter Capacitors*	8 kV

* These external power connections are only required on the larger horsepower Medium Voltage Drives.

Table 8.7 – Power Wire Selection (4160 V)

6000 and 6900 V Medium Voltage Drives

Pulse #	Isolation Transformer or Line Reactor	Cabling Source		Cable Insulation Rating
		From	To	
6, 12, 18	Isolation Transformer	Tx. Secondary or Secondaries	Line side converter (Drive)	15 kV
		Line side converter (Drive)*	Remote DC Link Reactor*	15 kV
		Remote DC Link Reactor*	Machine side converter (Drive)*	8 kV
		Machine side converter (Drive)	Motor	8 kV
		Machine side converter (Drive)*	Remote Motor Filter Capacitors*	8 kV
6	Line Reactor	Power System	Line side converter (Drive) or Input Contactor	8 kV
		Line side converter (Drive)*	Remote DC Link Reactor*	8 kV
		Remote DC Link Reactor*	Machine side converter (Drive)*	15 kV
		Machine side converter (Drive)	Motor	15 kV
		Machine side converter (Drive)*	Remote Motor Filter Capacitors*	15 kV

* These external power connections are only required on the larger horsepower Medium Voltage Drives.

Table 8.8 – Power Wire Selection (6600V and 6900V)

The following table, Table 8.9, identifies general wire categories that will be encountered when installing the Bulletin 1557 drive system. Each category has an associated wire group number that is used in the following sections to identify the wire to be used. Application and signal examples along with the recommended type of cable for each group are provided. A matrix providing the recommended minimum spacing between different wire groups run in the same tray or separate conduit is also provided.

Wire Category	Wire Group	Application	Signal Example	Recommended Cable	For Tray: Recommended spacing between different wire groups in the same tray. For Conduit: Recommended spacing for wire groups in separate conduit – inches (mm).						
					Wire Group	Power 1	Power 2	Control 3	Control 4	Signal 5	Signal 6
Power	1	AC Power (> 600V AC)	2.3 kV, 3Ø AC Lines	Per NEC Local Codes and Application Requirements	In Tray	9.00 (228.6)	9.00 (228.6)	9.00 (228.6)	9.00 (228.6)		
					Between Conduit	3.00 (76.2) Between Conduit					
	2	AC Power (TO 600V AC)	480V, 3Ø	Per NEC Local Codes and Application Requirements	In Tray	9.00 (228.6)	9.00 (228.6)	6.00 (152.4)	6.00 (152.4)		
						Between Conduit	3.00 (76.2) Between Conduit				
Control	3	115V AC or 115V DC Logic	Relay Logic PLC I/O	Per NEC Local Codes and Application Requirements	In Tray	9.00 (228.6)	6.00 (152.4)	9.00 (228.6)	6.00 (152.4)		
		115V AC Power	Power Supplies Instruments		Between Conduit	3.00 (76.2) Between Conduit					
	4	24V AC or 24V DC Logic	PLC I/O	Per NEC Local Codes and Application Requirements	In Tray	9.00 (228.6)	6.00 (152.4)	6.00 (152.4)	9.00 (228.6)		
						Between Conduit	3.00 (76.2) Between Conduit				
Signal	5	Analog Signals DC Supplies	5-24V DC Supplies	Belden 8760 Belden 8770 Belden 9460							
		Digital (Low Speed)	Power Supplies TTL Logic Level								
	6	Digital (High Speed)	Pulse Train Input Tachometer PLC Communications	Belden 8760 Belden 9460 Belden 9463							

All signal wiring must be run in separate steel conduit. A wire tray is not suitable.

The minimum spacing between conduits containing different wire groups is 3.00 inches (76.2 mm).

Belden 8760 - 18 AWG, twisted pair, shielded
 Belden 8770 - 18 AWG, 3 conductor, shielded
 Belden 9460 - 18 AWG, twisted pair, shielded
 Belden 9463 - 24 AWG, twisted pair, shielded

- Note 1:** Steel conduit or cable tray may be used for all Bulletin 1557 power or control wiring, and steel conduit is required for all Bulletin 1557 signal wiring. All input and output power wiring, control wiring or conduit should be brought through the drive conduit entry holes of the enclosure. Use appropriate connectors to maintain the environmental rating of the enclosure. The steel conduit is REQUIRED for all control and signal circuits, when the drive is installed in European Union countries. The connection of the conduit, to the enclosure shall be on full 360 degree and the ground bound at the junction shall be less than 0.1 ohms. In EU countries this is a usual practice to install the control and signal wiring.
- Note 2:** Spacing between wire groups is the recommended minimum for parallel runs of 200 feet or less.
- Note 3:** All shields for shielded cable must be grounded at the drive end only. The other end must be insulated and remain floating. Shields for cables from one enclosure to another must be grounded only at the source end cabinet. If splicing of shielded cables is required, the shield must remain continuous and insulated from ground.
- Note 4:** AC and DC circuits must be run in separate conduits or trays.
- Note 5:** Voltage drop in motor leads may adversely affect motor starting and running performance. Installation and application requirements may dictate that larger wire sizes than indicated in NEC guidelines be used.

Table 8.9 – Wire Group Numbers

The wire sizes must be selected individually, observing all applicable safety and CEC or NEC regulations. The minimum permissible wire size does not necessarily result in the best operating economy. The minimum recommended size for the wires between the drive and the motor is the same as that used if a main voltage source connection to the motor was used. The distance between the drive and motor may affect the size of the conductors used.

Consult the wiring diagrams and appropriate CEC or NEC regulations to determine correct power wiring. If assistance is needed, contact your local Rockwell Automation Sales Office.

Physical Location

The drive is designed for front access and should be installed with adequate and safe clearance to allow for total door opening. The back of the unit may be placed against a wall and several units may be set end to end. In special cases where floor space is limited and the unit is not against a wall, certain cabinet sections may be placed back to back. This requirement must be stated in the specifications in order to mechanically alter the drive.

Ground Bus-Bar

Drives which are delivered in two or more sections for ease of handling will require that the ground bus-bar which runs the entire length of the drive on the inner back side, to be re-connected. When the sections are brought together the ground bus-bar's from each section are to be bolted together.

Power and Control Wiring

Drives which are delivered in two or more sections, for ease of handling, will require that the power and control wiring be re-connected. After the sections are brought together, the power and control wiring is to be re-connected as per the schematic drawings provided.

Control Cables

Control cable entry/exit should be located near the terminal block 'TBC' -the customer's connections are to be routed along the empty side of the TBC terminals. These terminals are sized to accept a maximum AWG #14 wire gauge. The low voltage signals (includes 4-20mA) are to be connected using twisted shielded cable, with a minimum AWG #18 wire gauge.

Of special concern is the tachometer signal. Two tachometer inputs are provided to accommodate a quadrature tachometer (senses motor direction). The tachometer power supply is isolated and provides +15 Volts and a ground reference. Many tachometer outputs have an open collector output, in which case a pull-up resistor must be added to ensure that proper signals are fed to the system logic.

IMPORTANT: Low voltage signals are to be connected using twisted shielded cable with the shield connected at the signal source end only. The shield at the other end is to be wrapped with electrical tape and isolated. Connections are to be as shown on the drawings provided.

Drive Cooling

Proper fan operation is essential to the performance of the drive. At installation, ambient temperature must not exceed 40 degrees Celsius. Check that all drive fans are operating and that there are no external hindrances to airflow.

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Introduction

This chapter will assist the user in start-up of a Bulletin 1557 drive. This chapter contains reference material with information regarding:

Recommended tools
Pre-Power checks
Verification of proper control voltages
Gating checks
Tuning (Autotuning as well as manual tuning)



WARNING: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.



CAUTION: The CMOS devices used on the control circuit boards can be destroyed or damaged by static charges. If personnel will be working near static sensitive devices, they must be appropriately grounded.

Recommended Tools and Equipment

The following list of tools is highly recommended for startup and tuning of a 1557 Medium Voltage Drive.

- Oscilloscope with memory
- Multimeter with assorted clip leads
- Assorted hand tools, with standard inch sockets and wrenches
- Approved contact type hot stick with appropriate high voltage gloves
- Static strap
- 5 kV Megger
- PLCC Chip Puller (Extraction tool)
- Torque Wrench

Pre-Power Checks

1. Verify that all installation guidelines have been met per Chapter 8.
2. Record all information, on the Medium Voltage Checklist listed below.

MEDIUM VOLTAGE CHECKLIST					
CUSTOMER					
APPLICATION					
LOCATION					
CUSTOMER DRIVE TAG/ID NAME					
JOB NUMBER / SERIES NUMBER					
COMMISSIONED BY				COMMISSIONED DATE	
DRIVE NAMEPLATE DATA					
VOLTS		AMPS		PULSE 6/12	
CAP KVAR		CAP VOLTS		CAP Δ OR Y	
DRIVE COOLING: AIR/LIQUID				CAP FREQUENCY	
DIMENSIONAL DRAWING NUMBER					
ELECTRICAL DRAWING NUMBER					
MOTOR NAMEPLATE DATA					
MANUFACTURER				HZ	
VOLTS		FLA		S.F.	
SYNC RPM		FL RPM		HP OR KW	
SERIAL NUMBER				P.F.	
TYPE/MODEL				FRAME	
CLASS		TEMP RISE		NEMA	
STATOR RTD				BEARING RTD	

TACHOMETER NAMEPLATE DATA				
MANUFACTURER				PPR
TYPE/MODEL			GEAR RATIO	
ISOLATION TRANSFORMER \ LINE REACTOR NAMEPLATE DATA				
ISOLATION TRANSFORMER SERIAL NUMBER →				LINE REACTOR SERIAL NUMBER →
MANUFACTURER				TEMP RISE
PRI VOLT		SEC VOLT		KVA / AMPS
PRIMARY CONNECTIONS				TYPE/MODEL
SECONDARY CONNECTIONS				
TAP SETTINGS				IMPEDANCE
DC LINK NAMEPLATE DATA				
MANUFACTURER and SERIAL NUMBER				TYPE/MODEL
AMPERES			INDUCTANCE	
INSULATION CLASS				TEMP RISE
THERMISTORS		CONNECTED		NOT CONNECTED

ADDITIONAL INFORMATION

HARMONIC FILTER DATA					
FIFTH					
EACH CAP KVAR		FARADS		QUANTITY	
CAPACITOR FREQUENCY			FUSE RATING AND TYPE		
REACTOR SIZE: AMP			MILLI HENERIES		
REACTOR TAP CONN					
CT/RATIO			OVERLOAD ELEMENTS		
SMP FLA SETTING					
SEVENTH					
EACH CAP KVAR		FARADS		QUANTITY	
CAPACITOR FREQUENCY			FUSE RATING AND TYPE		
REACTOR SIZE: AMP			REACTOR SERIAL NUMBER / MILLI HENERIES		
REACTOR TAP CONN					
CT/RATIO			OVERLOAD ELEMENTS		
SMP FLA SETTING					
ELEVENTH					
EACH CAP KVAR		FARADS		QUANTITY	
CAPACITOR FREQUENCY			FUSE RATING AND TYPE		
REACTOR SIZE: AMP			REACTOR SERIAL NUMBER / MILLI HENERIES		
REACTOR TAP CONN					
CT/RATIO			OVERLOAD ELEMENTS		
SMP FLA SETTING					
THIRTEENTH					
EACH CAP KVAR		FARADS		QUANTITY	
CAPACITOR FREQUENCY			FUSE RATING AND TYPE		
REACTOR SIZE: AMP			REACTOR SERIAL NUMBER / MILLI HENERIES		
REACTOR TAP CONN					
CT/RATIO			OVERLOAD ELEMENTS		
SMP FLA SETTING					

ADDITIONAL INFORMATION (cont.)

HARMONIC FILTER DATA					
SEVENTEENTH					
EACH CAP KVAR		FARADS		QUANTITY	
CAPACITOR FREQUENCY			FUSE RATING AND TYPE		
REACTOR SIZE: AMP			REACTOR SERIAL NUMBER / MILLI HENERIES		
REACTOR TAP CONN					
CT/RATIO			OVERLOAD ELEMENTS		
SMP FLA SETTING					

3. Record all information pertaining to revision levels on the chart below.

DRIVE CIRCUIT BOARDS			
ACRONYM	PART NUMBER	HARDWARE REVISION	SOFTWARE REVISION
DCB LINE			
DCB MACHINE			
LINE OIB			—
MACHINE OIB			—
VFB 1			—
VFB 2			—
VFB 3			—
VFB 4			—
CPB			
50V POWER SUPPLY			—
PANELVIEW 550			
TFB 1			—
TFB 2			—
TFB 3			—
TFB4			—
TFB 5			—
TFB6			—
TFB7			—
SCRGD BOARD			—
SCR IGDPS BOARD			—
GTOGD BOARD			—
GTO IGDPS BOARD			—
DIGITAL I/O BOARD			—
REMOTE I/O BOARD			
DC/DC CONVERTER			
TACH FEED BACK BOARD			—
H.I.M. MODULE			
SCAN BUS POWER SUPPLY			—
TACHOMETER POWER SUPPLY			—
PRINTER			—

FAULT MASKS

Line selfst	
Line param	
Line s/w w/d	
Line h/w w/d	
Line s/w o/c	
Line h/w o/c	
Line ac o/v	
Line dc o/v	
Line phasing	
Ground fault	
Ln thy open	
Ln thy short	
Ac cntrl pwr	
Ln unbalance	
Input open	
Pulse number	
Mtr selftest	
Mtr param	
Mtr s/w w/d	
Mtr h/w w/d	
Mtr s/w o/c	
Mtr h/w o/c	
Mtr ac o/v	
Mtr dc o/v	
Mtr stall	
25 not used	
Mtr thy open	
Mtr thy shrt	
dc cntrl pwr	
Mtr unbalance	
Output open	
No Vdc fdbk	
Drv overload	
Mtr overload	
Mtr overspd	
Control temp	
Sync xfer fail	
Neutral o/v	
Scanport fault	
New firmware	
Overtemp 1	
Overtemp 2	
Overtemp 3	
Undertemp	
Overtemp 5	
Overtemp 6	
Overtemp 7	

Firmware rev	
External 1 [512]	
External 2 [513]	
External 3 [514]	
External 4 [515]	
External 5 [516]	
External 6 [517]	
External 7 [518]	
External 8 [519]	
External 9 [520]	
External 10 [521]	
External 11 [522]	
External 12 [523]	
External 13 [524]	
External 14 [525]	
External 15 [526]	
External 16 [527]	
Drv o/l warn	
Mtr o/l warn	
Line u/v	
Line rvs seq	
Input open	
Input closed	
Output open	
Output closed	
Bypass open	
Bypass closed	
Tach loss	
H/w o/c warn	
H/w o/v warn	
Tach rotn	
Line Sync	
Control temp wrn	

On = 1**Off = 0**

Analog Outputs	
Port 1 – Analog 1L	
Port 2 – Analog 2L	
Port 3 – Analog 3L	
Port 4 – Analog 4L	
Port 5 – Analog 1M	
Port 6 – Analog 2M	
Port 7 – Analog 3M	
Port 8 – Analog 4M	
Port 9 – Analog 5L	
Port 10 – Analog 6L	
Port 11 – Analog 5M	
Port 12 – Analog 6M	

PLC Inputs	
Port1 – Link A1	
Port 2 – Link A2	
Port 3 – Link B1	
Port 4 – Link B2	
Port 5 – Link C1	
Port 6 – Link C2	
Port 7 – Link D1	
Port 8 – Link D2	

PLC Outputs	
Port 1 – Link A1	
Port 2 – Link A2	
Port 3 – Link B1	
Port 4 – Link B2	
Port 5 – Link C1	
Port 6 – Link C2	
Port 7 – Link D1	
Port 8 – Link D2	

Temperature Feedback Board Dip Switch Settings
 (Nominal Setting is 85°C)

SWITCH	TFB1	TFB2	TFB3	TFB4	TFB5	TFB6	TFB7	TEMP IN °C
DIP1								85
DIP2								90
DIP3								95
DIP4								100

RIO Communication Module Dip Switch Settings
 (1203-GD1 / 1336 GM1)

SWITCH	1	2	3
DIP1			
DIP2			
DIP3			
DIP4			
DIP5			
DIP6			
DIP7			
DIP8			

KEY X = ON
 O = OFF

External Fault Messages

EXTERNAL FAULT	FAULT MESSAGE
1 [512]	
2 [513]	
3 [514]	
4 [515]	
5 [516]	
6 [517]	
7 [518]	
8 [519]	
9 [520]	
10 [521]	
11 [522]	
12 [523]	
13 [524]	
14 [525]	
15 [526]	
16 [527]	

4. The following mechanical checks should be carried out and the drive is inspected for shipping damage.
 - a. Torque all bolts and screws as required.
 - b. Check all wires and lugs for signs of stress and wear
 - c. Make sure all grounds are permanent and secure
 - d. Check all phasing to the drive. This is especially important if the system is a 12 or 18 pulse or has bypass.
5. Check all interlocks and Kirk Key switches. If these are not functioning properly, it should be reported to the factory immediately.
6. Check for protective barriers that may have been removed during installation or shipment.
7. Inspect the following for value with an ohmmeter.
 - a. Check all power resistors. Placement of these resistors may be viewed in the Hardware description earlier in this manual.
 - b. Check all power semiconductors (SCRs, GTOs)
 - c. Using an ohmmeter, measure the anode to cathode, anode to gate, and cathode to gate. The resistance in circuit will differ from out of circuit where other assemblies provide a parallel path.

DEVICE	TEST POINTS	EXPECTED MEASUREMENT
GTO	ANODE TO CATHODE ANODE TO GATE CATHODE TO GATE	> 400K Ω > 400K Ω > 20 Ω
SCR	ANODE TO CATHODE ANODE TO GATE CATHODE TO GATE	> 2M Ω >2M Ω 12 Ω
DIODE	ANODE TO CATHODE	20 Ω

Please note the actual resistance measurement will depend upon the device and the ohmmeter used. It is not possible to accurately measure unclamped semiconductor devices.

If a short is found, isolate the device on the stack and verify that the device is faulty, only then proceed with removing the stack from the drive.

If the semiconductor device is not suspected of being faulty, test other surrounding components, or call your local Rockwell Automation service representative for assistance.

Line Reactor versus Isolation Transformer

Displaced Neutral Voltage

Current source inverters (CSI) create a displaced neutral voltage. The CSI drive uses a large DC link inductor, and as a result, there is a phase shift in the neutral voltage between the rectifier and the inverter. The effect is that a drive which is operated from a grounded supply system, without a isolation transformer, will produce a high neutral to ground voltage and therefore higher phase to ground voltage on the drive output. The Motor winding insulation must be increased to handle the increased voltage stress.

In an existing system, where the motor could not handle this increased voltage stress, an ungrounded isolation transformer can be used on the line side of the drive and a grounding network added to the output side of the drive. This would transfer the higher phase to ground voltage to the primary side of the drive and onto the isolation transformer winding. It is simpler to design the transformer for the increased voltage stress. This solution is the only method for retrofit applications. where a drive is added to control an existing motor.

Isolation Transformer Applications:

The drive's output grounding network must be connected This will transfer the higher phase to ground voltage to the primary side of the drive and onto the isolation transformer winding. The drive's output grounding network clamps the motor's wye point to near ground potential and a ground fault will displace this neutral voltage. The neutral voltage impressed upon the motor is typically used to detect a ground fault on a drive equipped with an isolation transformer. A steady state neutral voltage of over 0.20 p.u. almost certainly signifies that a ground fault exists somewhere in the drive or in the equipment connected to the drive's output.

Note: The drive parameters used to set up ground fault protection on a Isolation transformer application are "Gnd Flt Overvoltage Trip" and "Gnd Flt Overvoltage Delay". The parameters are located in the "P Mach Protect" parameters group.

Note: The drive's output neutral voltage can be monitored by observing the variable "V Neutral Motor", the variable is located under the Display Group "V Motor Model" motor model variables group. Verify that the running "V Neutral Motor" variable is under 0.20 p.u

Line Reactor Applications

In a line reactor application, the bus feeding the input to the drive must have a reference to ground. This may be in the form of a grounded wye point of the feeder transformer or a ground resistor network on the feeder bus. The zero sequence C.T. located on the drive input will detect any current flowing to ground during a ground fault condition in the drive or at the motor.

Note: The drive's internal output grounding network must be disconnected! If the drive's output grounding network is left connected, it will result in approximately 1 to 2 amps of ground current. The default value for the "Ground Fault Overcurrent Trip" has been lowered to 0.5 amps with a 1.0 amp maximum. If the output-grounding network is left connected it will nuisance trip the drive and may also trip the customer's upstream protection relay.

Note: The parameters used to set-up ground fault protection on a Line Reactor application are "Gnd Flt Overcurrent Trip" and "Gnd Flt Overcurrent Delay". The parameters are located under the P Line Protect parameters group.

Note: The neutral voltage on a line reactor application varies from approximately 0.3 to 0.6 p.u. You will have to increase the "Gnd Flt Overvoltage" setting to 0.7 or greater to prevent nuisance trips.

Note: Drive ground fault current can be monitored by observing the variable "Gnd Flt Current". The variable is located under the Analog I / O Variable group. Monitor the variable "V Motor Neutral" and verify that the variable is running at a value greater than 0.3 p.u. This will confirm that the customer has their input feed referenced to ground. Monitor the variable "Gnd Flt Current" and verify that with the drive's output grounding network disconnected, the Gnd Flt Current is not greater than 0.5 amps

Meggering the 1557 Drive

NOTE: THIS IS NOT A HI-POT PROCEDURE

NOTE: Prior to performing the megger test, the following must be completed to prevent poor megger readings and damage to the drive control boards.

The following procedure is to be used during the commissioning the 1557. Meggering the drive allows you to find any ground faults without damaging the drive.

1. Disconnect any incoming power sources. Medium voltage sources should be locked off and all control power should be turned off at the circuit breaker.
2. Verify with potential indicator that power has been disconnected, also, the control power in the drive is de-energized.
3. Disconnect the following items:
 - The **J1, J2 and Gnd. Wires** on all four Voltage Feedback Boards (VFB). **Before removing the J1 and J2 connectors, label each one with 'J1' or 'J2' and arrow "↑" to note the polarity, this will mitigate the re-connection process.**
 - The Output Ground Network from the capacitor bank.
 - Disconnect the ground connection on the ground fault network.
4. Remove the fuses from any potential transformers connected to the system.
5. Megger the drive with a DC voltage equivalent of its AC rating. The reading should be at least 1000 MΩ for air cooled drives and 200 MΩ for liquid cooled drives, preferred is 10 000 MΩ plus for one minute.
6. Record the results:

Drive Input _____K meg ohms

NOTE: If isolation transformer or motor have been disconnected, megger them individually and record the results:

Motor _____K meg ohms

Transformer _____K meg ohms

7. **Discharge the system to ground before touching any equipment.**
8. Reconnect everything that was disconnected in step #3. **NOTE: It is important that the J1 and J2 ribbon cables are connected to the appropriate terminals on each board. Incorrect replacement of these cables will cause serious damage to the drive.** Replace all fuses that were removed, check that the correct fuse goes to the correct location.

If you obtain values below the recommended, contact Medium Voltage Product Support.

LOGIC POWER SUPPLY TESTS

1. Remove all the gate driver power supply leads, and all power supply connections to the printed circuit cards.
2. Inspect the low voltage terminal block, measure the 120/240 Volt supply voltages to be sure they are in limits. Record the voltages.

TEST POINT	EXPECTED VOLTAGE (AC)	MEASURED VOLTAGE (AC)
WIRE NUMBER D60 TO D61	90 TO 132 VOLTS	
WIRE NUMBER D-- TO D--	180 TO 264 VOLTS	

3. Turn on the low voltage breaker (CB1), this will power up the 50VDC logic power supply. Take the readings at the DC to DC converter terminal blocks. Record the voltages in the table below:

FUNCTION	TEST POINT	EXPECTED VOLTAGE (DC)	MEASURED VOLTAGE (DC)
TACHOMETER	WIRE NUMBER D59 TO D58	+15	
LEMS	WIRE NUMBER D56 TO D57	+24 ± 3%	
	WIRE NUMBER D55 TO D57	-24 ± 3%	
DCB	WIRE NUMBER D54 TO D53	5.1V TO 5.3V	
	WIRE NUMBER D52 TO D51	+15V ± 3% (1A)	
	WIRE NUMBER D50 TO D51	- 15V ± 3% (1A)	
TRANSDUCERS AND PRINTER	WIRE NUMBER D48 TO D49	+24	
SCANBUS	WIRE NUMBER D46 TO D47	+12	
DC POWER INPUT	WIRE NUMBER D44 TO D45	+50	

Rectifier Power Supply Readings 6- or 12-pulse Bridge

BOARD COMBINATION	POSITIVE RAIL TP4 to TP15	NEGATIVE RAIL TP3 to TP15
80165-178-52 with 80165-158-51/53/54	+22.50V to +23.00V	-5.0V to -6.0V
80165-698-52 with 80165-158-51/53/54	+22.50V to +23.00V	-5.0V to -6.5V

NOTE: Adjust the voltage at TP4 first and then verify that the voltage at TP3 is within the range described.

Voltage Drift Limits

The maximum allowable drift range for the positive rail is between +27.25 V and +18.25 V

The maximum allowable drift range for the negative rail is between -7.0V and -4.3V

SLAVE (WYE WINDING)

1a		3a		5a	
1b		3b		5b	
1c		3c		5c	
1d		3d		5d	
4a		6a		2a	
4b		6b		2b	
4c		6c		2c	
4d		6d		2d	

MASTER (DELTA WINDING)

1a		3a		5a	
1b		3b		5b	
1c		3c		5c	
1d		3d		5d	
4a		6a		2a	
4b		6b		2b	
4c		6c		2c	
4d		6d		2d	

Rectifier Power Supply Readings 18-pulse Bridge

BOARD COMBINATION	POSITIVE RAIL TP4 to TP15	NEGATIVE RAIL TP3 to TP15
80165-178-52 with 80165-158-51/53/54	+22.50V to +23.00V	-5.0V to -6.0V
80165-698-52 with 80165-158-51/53/54	+22.50V to +23.00V	-5.0V to -6.5V

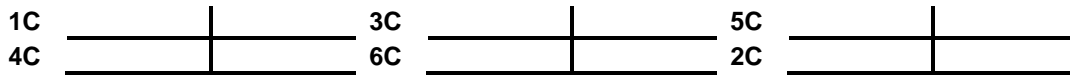
NOTE: Adjust the voltage at TP4 first and then verify that the voltage at TP3 is within the range described.

Voltage Drift Limits

The maximum allowable drift range for the positive rail is between +27.25 V and +18.25 V

The maximum allowable drift range for the negative rail is between -7.0V and -4.3V

SLAVE 2 Bridge (Plus 20 Degree Winding)



SLAVE 1 Bridge (Minus 20 Degree Winding)



MASTER Bridge



Inverter Power Supply Readings

800 / 1500 AMP G.T.O.		
BOARD COMBINATIONS	POSITIVE RAIL TP5 to TP15	NEGATIVE RAIL TP3 to TP15
80165-178-51 with 80165-138-53/54	+7.5V to +8.8V	-12.45V to -12.55V
80165-698-51 with 80165-138-53	+7.5V to +9.0V	-12.45V to -12.55V
80165-698-51 with 80165-138-54	+7.5V to +10.0V	-12.45V to -12.55V
NOTE: Adjust the voltage at TP3 first and then verify that the voltage at TP5 is within the range described.		
Voltage Drift Limits		
The maximum allowable drift range for the positive rail is between +10.0V and +7.0V		
The maximum allowable drift range for the negative rail is between -15.0V and -11.5V		
BOARD COMBINATIONS	POSITIVE RAIL TP20 to TP32	NEGATIVE RAIL TP16 to TP32
80165-958-51 with 80190-058-51/52	+8.60 to +9.40	-12.10 to -12.90
NOTE: Self-calibrating no adjustment required. Verify voltage values only.		
3000 AMP G.T.O.		
BOARD COMBINATION	POSITIVE RAIL TP17 to TP18 TP10 to TP5	NEGATIVE RAIL TP13 to TP5
80165-958-53 with 80165-978-53	+12.50V to +13.50V +7.80V to +8.20V	-19.70V to -20.30V
NOTE: Self-calibrating no adjustment required. Verify voltage values only.		
BOARD COMBINATION	POSITIVE RAIL TP20 to TP32	NEGATIVE RAIL TP16 to TP32
80165-958-53 with 80190-058-53	+12.60 to +13.40	-19.60 to -20.40
NOTE: Self-calibrating no adjustment required. Verify voltage values only.		
BOARD COMBINATION	POSITIVE RAIL TP19 to TP16	NEGATIVE RAIL TP13 to TP16
80165-178-51 with 80165-758-53	+11.40V to +12.60V	-19.90V to -20.10V
NOTE: Adjust the voltage at TP13 first and then verify that the voltage at TP19 is within the range described.		

1a	_____	3a	_____	5a	_____
1b	_____	3b	_____	5b	_____
1c	_____	3c	_____	5c	_____
1d	_____	3d	_____	5d	_____
4a	_____	6a	_____	2a	_____
4b	_____	6b	_____	2b	_____
4c	_____	6c	_____	2c	_____
4d	_____	6d	_____	2d	_____

Configuring the Drive

From the information collected, on the Medium Voltage Checklist, enter all nameplate parameters in the drive, through the operator terminal. This may be accomplished by pressing the "SETUP" (F8) softkey from the PanelView 550 main screen. The named boxes at the bottom of the screen correspond with the F1 through F10 keys on the PanelView terminal. During the course of modifying the parameters the PanelView 550 may prompt you to save the parameters entered. It is recommended you save all parameters. More information on the operator terminal and the parameter may be obtained from Chapters 5,6, and 7.

From the setup screen, press the "PARAMS" (F7) softkey.

From the parameter screen use the arrow keys to select "Nameplate" options, and press enter. Select each of the nameplate parameters with the arrow keys and press enter. Modify each parameter value until correct. The two entries that may be require special attention are the "Rated motor KW" which does not need to be entered, if the "Rated motor HP" is entered. The HP does not need to be entered, if the KW is entered. The "Tach pulses/rev" does not need to be entered, if that option board does not exist in the drive.

```

REV 2.20
      ALLEN-BRADLEY
      BULLETIN 1557 MV DRIVE

Status: NOT READY  Speed:      0 rpm
          Current:    0 A
Faults:  0          Voltage:   0 U
Warnings: 0         Power:    0 kW
    
```

HELP	UTILITY	PRINT	DISPLAY	EEPROM
ALARMS	STATUS	SETUP	DIAGS	ACCESS

```

SETUP:

      MODE: Unrestricted
    
```

HELP	ANALOG	PLC	FAULTS	EXTERN
ALARMS	PARAMS	ACCESS		EXIT

```

SELECT GROUP: 1 of 2

P Feature Select
P Nameplate
P Speed Command
P Skip Speeds
P Speed Ramp
P Speed Control
P Flux Control
P Current Control
    
```

ALARMS	LIST	NEXT PG	PREV PG	EXIT
--------	------	---------	---------	------

```

SELECT: P Nameplate 1 of 2

Rated line freq      60      Hz
Rated line volts    2400     U
Rated drive amps    110      A
Capacitor kvar      200     kvar
Capacitor volts     2400     U
Capacitor freq      60      Hz
Rated motor volt    2300     U
Rated motor amps    110      A
    
```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

```

SELECT: P Nameplate 2 of 2

Rated motor kw      373      kW
Rated motor hp      500      hp
Rated motor rpm     1185.0   rpm
Link inductance     32.0     mH
    
```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

To change a value, select the correct entry from the previous figures and press enter. Then enter the value desired. In this example we change the line voltage to 4160 volts. When finished press the F10 softkey to exit.

```

MODIFY PARAMETER: Rated line volts

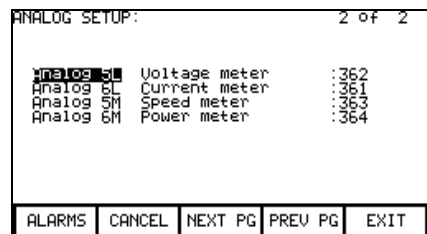
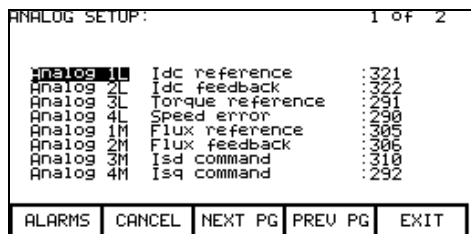
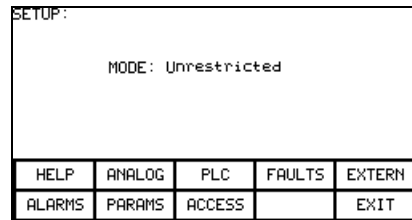
      P: 18

Min:      1000      U
Actual:   2400
New:      4160
Max:      7200
    
```

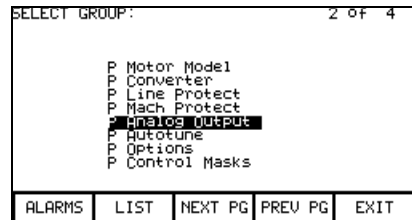
ALARMS	CANCEL	ACCESS		EXIT
--------	--------	--------	--	------

Review the associated metering connected to the analog outputs and configure the meter scaling.

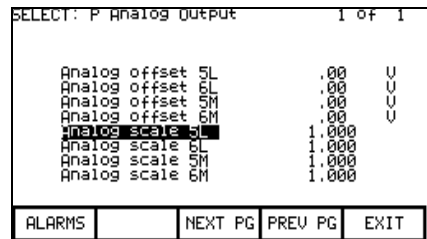
To assign external panel meters or analog ports, press the "SETUP" (F8) softkey from the top level main menu.. From the SETUP menu in the figure press the "ANALOG" (F2) softkey. There are two pages of assignments shown below in the figures. Use the arrow keys to select a port and from the menu's displayed after, select a variable to assign to it.



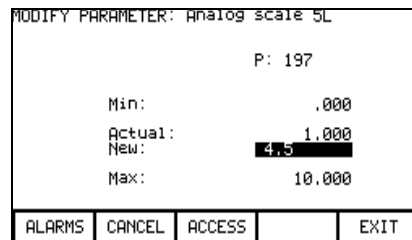
From the main screen, press the "SETUP" (F8) softkey. Then press the "PARAMS" (F7) softkey. From the parameter select group screen, use the "NEXT PAGE" (F8) softkey to arrive at page 2. Use the arrow keys to cursor down to "P Analog Output", and press enter.



It will be necessary to set up the analog scale outputs. After determining to which outputs the metering is connected, calculate the scale, from the equations below. Once this is obtained, cursor to the correct analog scale output and press enter.



Enter the calculated value and press return, then press the F10 softkey to exit.



To calculate the scale factor for the meter, take the meter full scale over the drive analog output scaling as seen below.

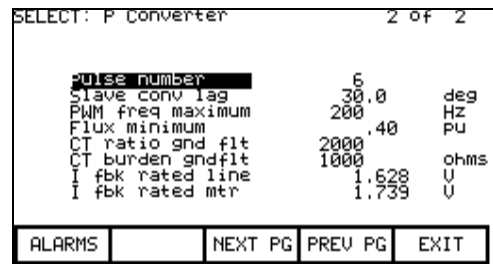
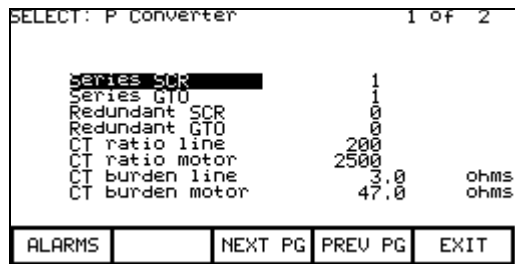
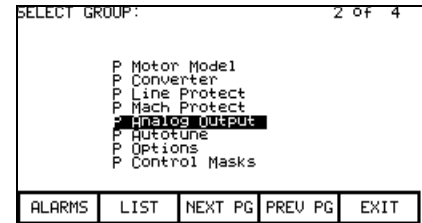
$$\text{Scale Factor} = \frac{\text{Analog Output Scale}}{\text{Meter Scale}}$$

See the parameter and variable description in Chapter 6 for more information. For example, a 0 to 5000 RPM meter would have a scale factor of

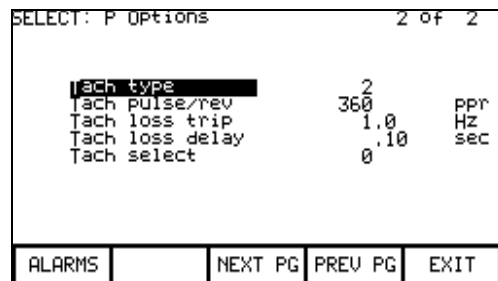
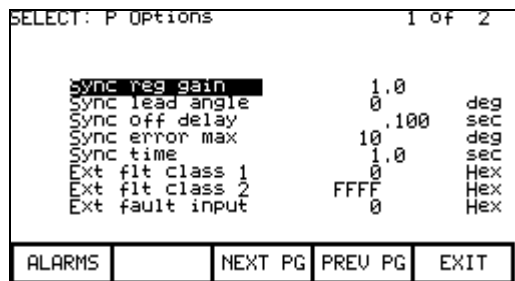
$$\text{Speed Scale Factor} = \frac{4096}{5000} = .8192$$

It will be necessary to verify other information regarding the drive. From the converter screen, check the following entries:

- The number of series and redundant devices in each leg.
- The CT ratios (LINE and MACHINE).
- Burden resistor values.
- Pulse number (6 or 12). It is extremely important that this is correct, as the drive will configure itself differently in each case. Call a Rockwell Automation Global Technical representative for assistance if you are unsure.



If the drive has a tachometer, it must also be set up. To setup the tachometer, go to the OPTIONS group of the parameter screen. Enter the tachometer type and the pulses per revolution.



Standard I/O Checks

The drive is shipped with a number of input and output termination's for auxiliary equipment to be attached to. This will appear on the drive drawing shipped with the drive.

- All start and stop circuits should be verified.
- All configurable alarms circuits should be checked.
- All status indicators should be checked for operation.
- All speed inputs to the drive should be checked for accuracy and calibration.

Gating Checks

- Ensure each Digital Control board's green "HEALTHY" light is on. Also ensure the Communications processor's "ACTIVE" light is on. If either of these conditions are not met call a Global Technical Services representative for assistance.
- From the main screen press the "SETUP" (F8) softkey. The screen is displayed, press the "PARAMS" (F7) SOFTKEY. The screen at the right will be displayed. Press the return key when the "P Feature Select" menu item is highlighted.

```

SELECT GROUP: 1 of 2
P Feature select
P Nameplate
P Speed Command
P Skip Speeds
P Speed Ramp
P Speed Control
P Flux Control
P Current Contrl
ALARMS LIST NEXT PG PREV PG EXIT

```

Move the arrow keys until the "test mode" entry is highlighted, and press enter.

```

SELECT: P Feature select 1 of 2
Contactor config 0
IO configuration 0
Auto restart dly 0.000 sec
test mode 0
Deflt spd select 1
Speed cmd select 9
Reverse enable 1
Debug mode 0
ALARMS NEXT PG PREV PG EXIT

```

Set the drive control parameter "Test mode" equal to 1, and press enter. Press the exit (F10) softkey.

```

MODIFY PARAMETER: test mode
P: 4
Min: 0
Actual: 0
New: 1
Max: 3
ALARMS CANCEL ACCESS EXIT

```

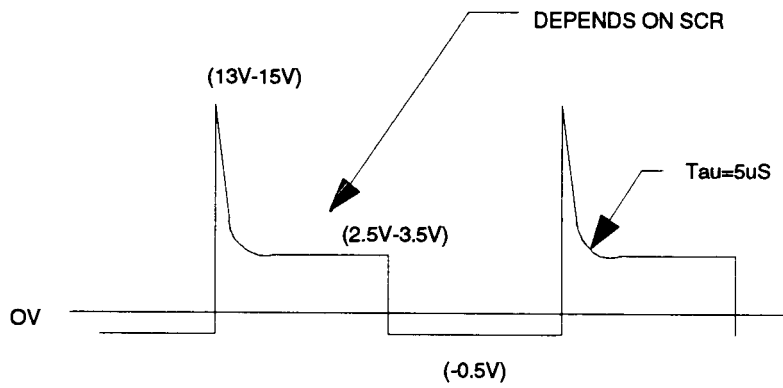
The drive display should show the "test mode" entry now set to 1 as the example at the right. Ensure that the drive status shows a drive ready. Press the start button, the drive should go into run mode and start gating. For more information refer to the Operator Interface chapter.

```

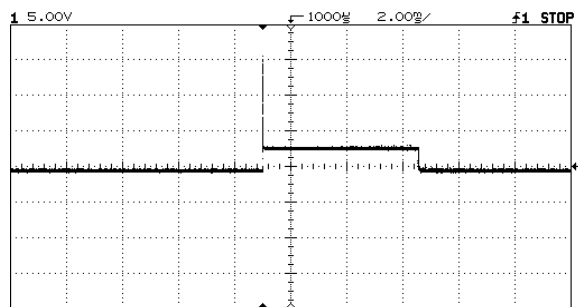
SELECT: P Feature select 1 of 2
Contactor config 0
IO configuration 0
Auto restart dly 0.000 sec
test mode 1
Deflt spd select 1
Speed cmd select 9
Reverse enable 1
Debug mode 0
ALARMS NEXT PG PREV PG EXIT

```

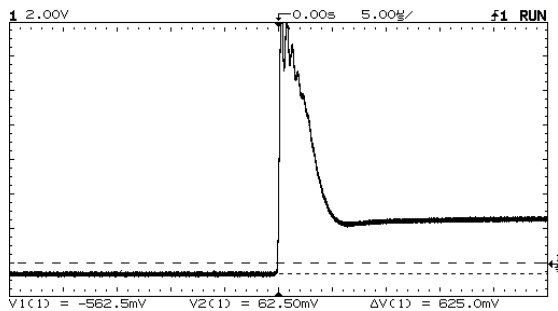
- For each SCR in the Line side converter section verify that the gating signal, gate to cathode, is identical to that shown below.



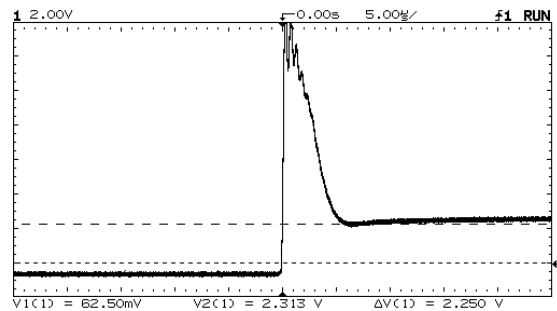
SCR-GATE CATHODE VOLTAGE



LINE SIDE CONVERTER GATE PULSE

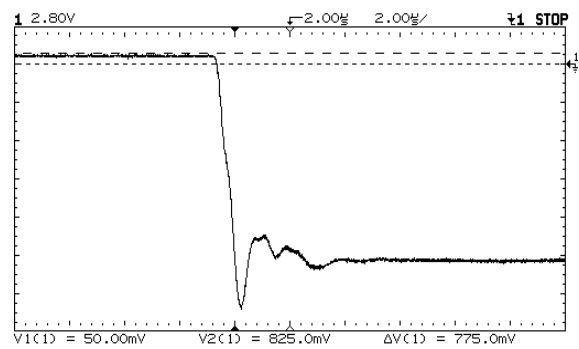
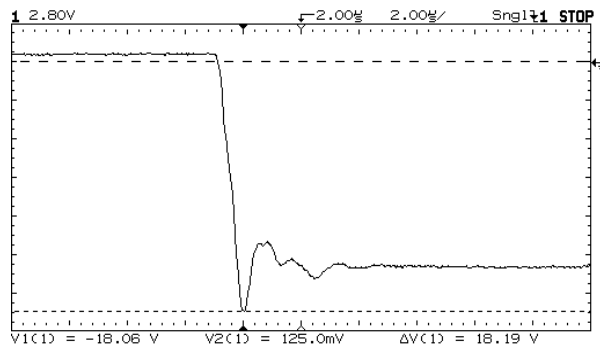
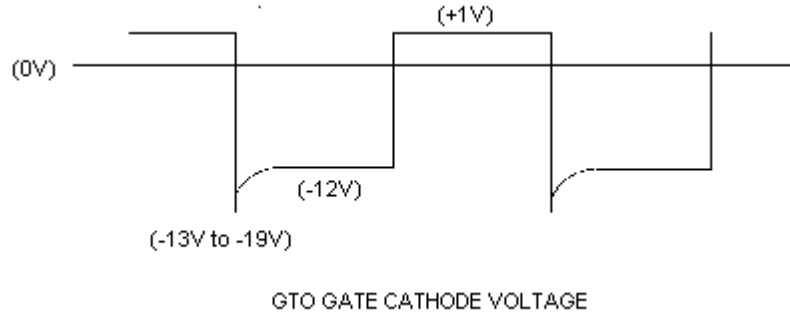


LINE SIDE CONVERTER GATE PULSE



LINE SIDE CONVERTER GATE PULSE

Monitor each GTO gate cathode of the Machine Side Converter section and verify that the signal is identical to that shown below.

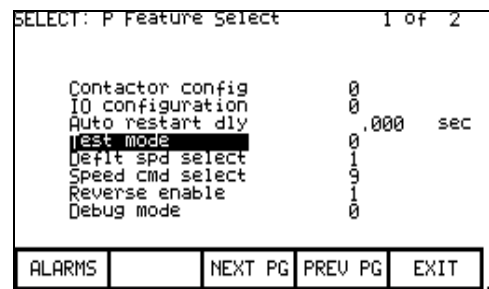
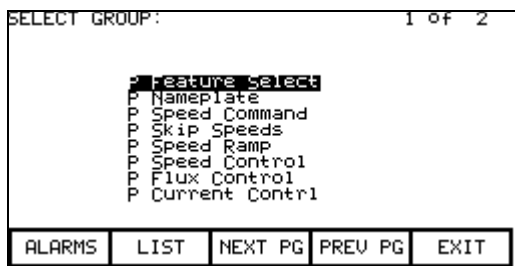


Application of Medium Voltage

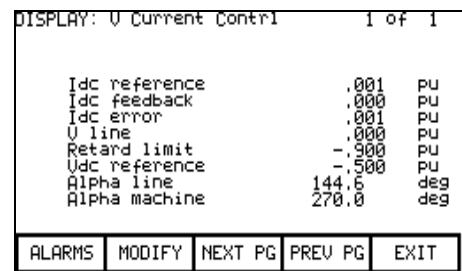
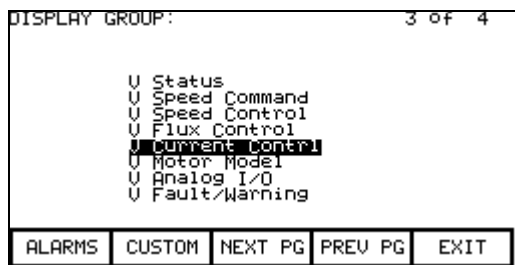


ATTENTION: Medium voltage power levels must be applied to the drive to perform the following start-up procedure. To avoid electric shock hazard, or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **DO NOT PROCEED**. Remove power, and lock out the source. Confirm discharge of stored energy. Correct the malfunction before continuing.

1. Confirm that all medium voltage safety doors are closed and all interlocks are functional. All Kirk Keys, if used, should be functional.
2. Ensure that parameter "Test mode" is set to zero. This is the normal operating mode.
3. Make sure the contactor configuration is correctly entered. The explanation for this may be found in Chapter 6. To change the contactor configuration, press the "SETUP" (F8) softkey from the top level main screen. Press the "PARAMS" (F7) softkey. The left figure (below) will display the parameter screen. Select the "P Feature Select" group and press return. The right figure (below) shows the current setting. Press return to change the contactor configuration.



4. Apply Medium Voltage levels, by raising the isolation switch on the input section. The input contactor will also need to be closed. Ensure the status display indicates a ready condition. Check the line voltage, as shown below, from the terminal to confirm optimum nominal input voltage. From the top level menu, press "DISPLAY" (F4) softkey. Using the "NEXT PG" (F8) softkey select the third page, and using the arrow keys, cursor down to "V Current Contrl" and press enter. You may now view the per unit line voltage (based on the rated motor voltage).



Tuning Procedure

The Bulletin 1557 medium voltage drive must be tuned to the motor and load to which it is connected. There are six drive functions that require tuning. These are listed below in the order in which they are usually performed:

Commutation Inductance	Autotune Select = 1
Current Regulator	Autotune Select = 2
Motor stator resistance	Autotune Select = 4
Motor leakage inductance	Autotune Select = 5
Flux Regulator	Autotune Select = 6
Speed Regulator	Autotune Select = 7

The first four functions can be tuned with the motor stationary, but the tuning of the flux and speed regulators requires the motor to rotate.

1. Commutation Inductance

The commutation inductance is used in the hardware reconstruction of the line voltage to compensate for commutation notches. It is also used in the calculation of the line converter retard limit to ensure proper operation under all conditions of line voltage and load current when regenerating. If the commutation inductance parameter is not correctly adjusted, the resulting distortion in the reconstructed line voltage may cause line synchronization faults.

The commutation inductance parameter is tuned with the drive operating in the dc current test mode. Although the commutation inductance was tuned during factory test, it must be retuned during commissioning because its value is determined by the impedance of the input transformer and harmonic filter (if present). The following autotune procedure can be used:

Commutation Inductance Autotuning

1. Set parameter "Autotune select" in "P Autotune" to 1. The drive will go into dc current test mode.
2. Start the drive. The dc current will increase in steps up to approximately rated current in about 2 seconds. When the current reaches its maximum value the drive shuts off.

Parameter "Autotune Lc" in "P Autotune" is set to the measured value of commutation inductance and parameter "Autotune select" is set to zero. If the test is successful, parameter "L commutation" in "P Current Control" is set equal to "Autotune Lc". If the test fails then parameter "L commutation" is not changed and a warning is issued indicating the cause of the failure:

L comm low - indicates that the measured commutation inductance is less than 0.02 pu. The commutation inductance must be tuned using the manual method described below.

L comm high - indicates that the measured commutation inductance is greater than 0.15 pu. The commutation inductance must be tuned using the manual method described below.

Commutation Inductance Manual Tuning

1. Set parameter "Test mode" in "P Feature Select" to 2 to enter dc current test mode.

SELECT: P Current Contr1			1 of 1
Curreg bandwidth	200	r/s	
L dc link	1.02	pu	
T dc link	.040	sec	
Advance limit	.990	pu	
L commutation	.10	pu	
Commutation mrgn	.10	pu	
Idc command test	.000	pu	
Idc ref step	.000	pu	

Current Control Parameter Screen

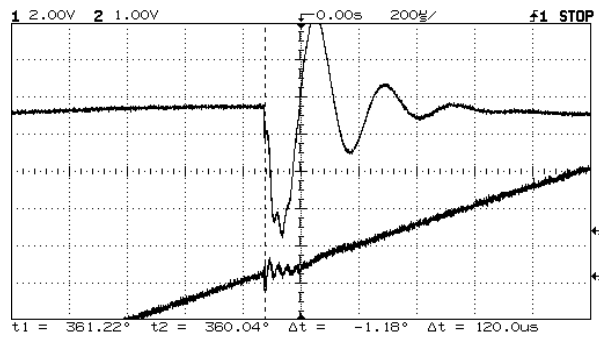
2. Set parameter "Idc command test" in "P Current Control" to 0.400 pu.
3. Set parameter "L commutation" in "P Current Control" to an initial value of 0.05 pu.
4. Connect an oscilloscope to the test points labeled V12 and F12 on the line converter control board. Two sine waves of approximately equal amplitude should be seen, with the reconstructed line voltage F12 lagging the unfiltered voltage V12 by 90 degrees. Adjust the triggering and time base to display the positive half cycle of V12 with a scale of 20 degrees per major division.
5. Start the drive. The dc link current will rise to 0.4 pu. Commutation notches will appear in the unfiltered line voltage V12 as shown in the figure. Some distortion will appear in the reconstructed voltage F12 around the zero crossings.
6. Measure the average width in degrees of the commutation notch nearest the peak of the V12 waveform as seen in the following figures.
7. Record the values of the variables "V line", and "Idc reference" in "V Current control"

DISPLAY: V Current Contr1			1 of 1
Idc reference	.001	pu	
Idc feedback	.000	pu	
Idc error	.001	pu	
V line	.000	pu	
Retard limit	-.900	pu	
Vdc reference	-.500	pu	
Alpha line	144.6	deg	
Alpha machine	270.0	deg	

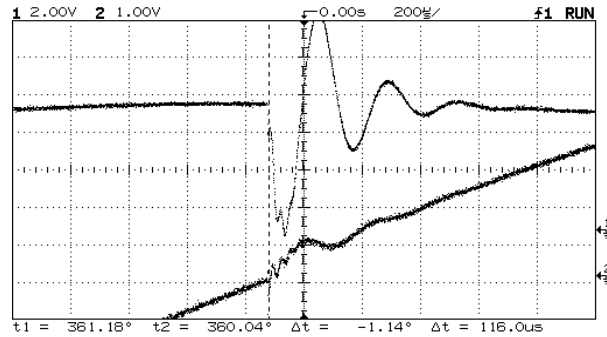
8. Calculate the commutation inductance using the following formula:

$$L \text{ commutation} = V \text{ line} \times \sin(\text{notch width}) / I_{dc} \text{ reference}$$

9. Set parameter "L commutation" to the calculated value. If there was visible distortion in the reconstructed voltage F12, the distortion should decrease. If the distortion increases, it is possible that the polarity of the line current feedback is backwards.



COMMUTATION INDUCTANCE TUNED CORRECTLY



COMMUTATION INDUCTANCE INCORRECTLY TUNED

10. Set parameter "Idc command test" to 0.800 pu. The dc current will increase and the commutation notches will become much larger.
11. Repeat steps 6 to 9. The higher current will produce a more accurate measurement of the commutation inductance.
12. Confirm that the commutation inductance is set to the correct value by increasing the horizontal and vertical magnification and observing the zero crossing of reconstructed voltage F12. Because the line converter firing angle is about 90 degrees, the commutation notch occurs near the zero crossing of the reconstructed voltage. The signal should be a straight line through the zero crossing with almost no visible distortion. Either increasing or decreasing parameter "L Commutation" should cause the distortion to increase.
13. Stop the drive. Set parameters "Test mode" and "Idc command test" to zero.

2. Current Regulator

The tuning of the current regulator is controlled by three parameters in the "P Current Control" group:

1. "Curreg bandwidth"
2. "L dc link"
3. "T dc link"

Of these three parameters, inductance "L dc link" is calculated from its nameplate rating, the current regulator bandwidth should be set to its default value of 200 rad/sec, and only "T dc link" is unknown and must be measured. Although the current regulator was tuned during factory test, it should be retuned during commissioning because the dc link time constant is affected by the impedance of the drive input transformer.

Current Regulator Autotuning

The current regulator can be tuned automatically using the following procedure:

1. Ensure that the parameters in the "P Nameplate" group have been set to the correct values, otherwise the calculated value of parameter "L dc link" in "P Current Control" will not be correct.
2. Set parameter "Autotune select" in "P Autotune" to 2. The drive will go into dc current test mode. The current regulator bandwidth is temporarily set to the value specified by parameter "Autotune Idc BW". The dc current command is set to the value specified by parameter "Autotune Idc cmd". The dc current step is set to the value specified by parameter "Autotune Idc stp".

3. Start the drive. The step response of the current regulator is measured and the dc link time constant is adjusted to produce a critically damped response. This test may take up to two minutes to perform. When the desired response has been achieved the drive shuts off.

The current regulator bandwidth is set back to its normal value and parameter "Autotune select" is set to zero. Parameter "Autotune Tdc" indicates the results of the test. If the test is successful, parameter "T dc link" in "P Current Control" is set equal to "Autotune Tdc". If the test fails then parameter "T dc link" is not changed and a warning is issued indicating the cause of the failure:

T dc low - indicates that the measured dc link time constant is less than 0.020 second. The step response of the current regulator should be checked using the manual method described below.

T dc high - indicates that the measured dc link time constant is greater than 0.100 second. The step response of the current regulator should be checked using the manual method described below.

Current Regulator Manual Tuning

An appropriate value for the "T dc link" parameter can be determined from the current regulator step response while operating in dc current test mode. The following procedure should be followed:

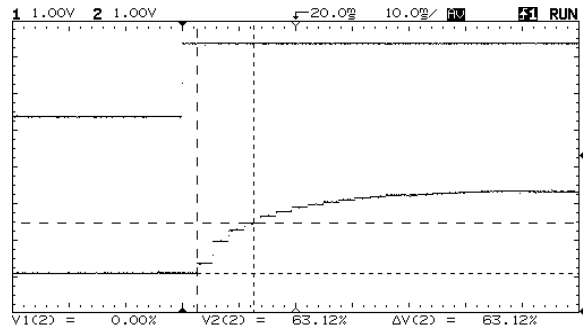
1. Be sure that all the parameters in the "P Nameplate" group have been set to the correct values, otherwise the calculated value of parameter "L DC link" in "P Current Control" will not be correct.
2. Set parameter "Test mode" in the "P Feature Select" to 2 to enter dc current test mode.

SELECT: P Current Contr1		1 of 1
Curreg bandwidth	200	r/s
L dc link	1.02	pu
T dc link	.040	sec
Advance limit	.990	pu
L commutation	.10	pu
Commutation mrgn	.10	pu
Idc command test	.000	pu
Idc ref step	.000	pu

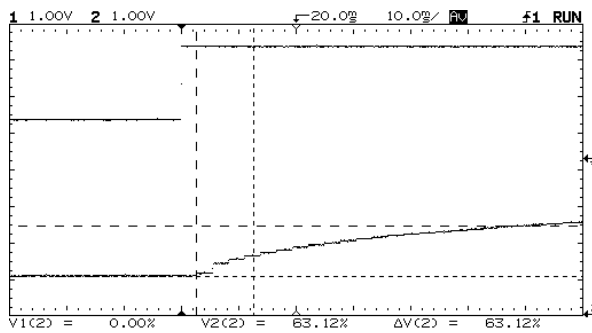
Current Control Parameter Screen

3. Set parameter "Idc command test" in "P Current Control" to 0.400 pu.
4. Set parameter "Curreg Bandwidth" in "P Current Control" to 100 rad/sec. A lower than the normal bandwidth makes the step response easier to measure.
5. Set parameter "T dc link" in "P Current Control" to 0.020 sec, which is at the low end of the normal range of values and should produce an underdamped response.
6. Assign variables "Idc reference" and "Idc feedback" in "V Current Control" to two of the line converter analog outputs (1 to 4) on the line converter (lower) control board and display them on a digital storage oscilloscope. These may be assigned the same way the external meters are assigned.
7. Start the drive. The dc link current will rise to 0.4 pu.
8. Set parameter "Idc ref step" in "P Current Control" to 0.200 pu. The dc link current will step up and down by this amount at regular intervals.

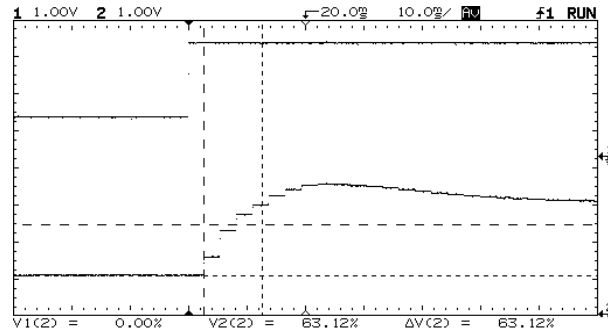
9. Adjust the scope to trigger on the rising edge of the dc current reference and observe the dc current feedback on the other channel. The step response will probably have noticeable overshoot, indicating that the dc link time constant is set too low.
10. Adjust parameter "T dc link" until the current feedback rises to about 63% of its final value in 10 ms as shown in the figure. The overshoot should now be quite small. Increasing "T dc link" causes the rise time to increase. Since the desired step response is slightly underdamped, "T dc link" should not be increased beyond the value at which the overshoot disappears.



CURRENT REGULATOR TUNED CORRECTLY



CURRENT REGULATOR TUNED INCORRECTLY



CURRENT REGULATOR TUNED INCORRECTLY

11. Set parameter "Curreg bandwidth" to the normal value of 200 rad/sec. Confirm that the rise time of the current feedback is now approximately 5 ms and that the overshoot is not excessive.
12. Set parameter "Idc ref step" to zero. The dc link current will return to a steady level of 0.4 pu.
13. Stop the drive.

3. Commutation Inductance and Current Regulator

It is possible to autotune the commutation inductance and current regulator at the same time using the following procedure:

1. Set parameter "Autotune Select" in "P Autotune" to 3. The drive will go into dc current test mode.
2. Start the drive. The commutation inductance autotuning is performed and then the current regulator autotuning is performed without stopping. When both tests are complete the drive shuts off.

The tests performed are the same as described previously for the commutation inductance and current regulator autotuning.

4. Stator Resistance

Parameter "R stator " is used in the hardware reconstruction of the rotor flux. If this parameter is not adjusted correctly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors. Stator resistance must be tuned during commissioning because it is effected not only by motor parameters but also by cable length. Stator resistance can be measured with the motor stationary. The following Autotune procedure can be used



ATTENTION: In the following steps the rotation of the motor in an undesirable direction may occur. To guard against possible equipment damage, it is recommended that the motor be disconnected from the load and tested for direction prior to proceeding, should the equipment be sensitive to reverse direction rotation.

1. Ensure that the motor is stationary. If the motor is turning the results of the test may be invalid. It is not necessary to lock the rotor.
2. Set parameter "Autotune select" in "P Autotune" to 4.
3. Start the drive. The output frequency ramps up to 2 Hz with the motor current remaining at zero.

The motor current then jumps up to approximately 0.10 pu for less than a second and the drive shuts off. This test produces a small amount of motor torque and some rotation may occur.

Parameter "Autotune Rs" is set to the measured Stator resistance and parameter "Autotune select" is set to zero. If the test is successful, parameter " Stator resistance " in "P Motor Model" is set equal to "Autotune Rs". If the test fails then parameter " Stator resistance " is not changed and a warning is issued indicating the cause of the failure:

R stator hi - this is probably caused by extremely long motor cables increasing the apparent stator resistance of the motor. The drive cannot operate with stator resistance greater than 0.20 pu.

5. Leakage Inductance

Parameter "L total leakage" is used in the hardware reconstruction of the rotor flux. If this parameter is not adjusted correctly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors. Leakage inductance must be tuned during commissioning because it is effected not only by motor parameters but also by cable length. Leakage inductance can be measured with the motor stationary. The following Autotune procedure can be used



ATTENTION: In the following steps the rotation of the motor in an undesirable direction may occur. To guard against possible equipment damage, it is recommended that the motor be disconnected from the load and tested for direction prior to proceeding, should the equipment be sensitive to reverse direction rotation.

1. Ensure that the motor is stationary. If the motor is turning the results of the test may be invalid. It is not necessary to lock the rotor.
2. Set parameter "Autotune select" in "P Autotune" to 5.
3. Start the drive. The output frequency ramps up to rated frequency in 2-3 seconds with the motor current remaining at zero. The motor current then jumps up to approximately rated current for less than a second and the drive shuts off. This test produces a small amount of motor torque and some rotation may occur.

Parameter "Autotune Ls" is set to the measured leakage inductance and parameter "Autotune select" is set to zero. If the test is successful, parameter "L total leakage" in "P Motor Model" is set equal to "Autotune Ls". If the test fails then parameter "L total leakage" is not changed and a warning is issued indicating the cause of the failure:

L leakage lo - indicates that the measured leakage inductance is less than 0.15 pu. Possible causes are:

1. The motor is much larger than the drive and the motor nameplate parameters do not correspond to the actual motor ratings. In this case, the measured leakage inductance is probably correct and parameter "L total leakage" should manually be set equal to "Autotune Ls".
2. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet, or if this is not possible, parameter "L total leakage" should be set to its default value of 0.20 pu.

L leakage hi - indicates that the measured leakage inductance is greater than 0.30 pu. Possible causes are:

1. The inductance of long motor cables is increasing the apparent leakage inductance of the motor. In this case, the measured leakage inductance is probably correct and parameter "L total leakage" should manually be set equal to "Autotune Ls".
2. The motor is very small (leakage inductance generally increases with decreasing motor size).
3. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet, if this is not possible, parameter "L total leakage" should be set to its default value of 0.20 pu.

6. Flux Regulator

For the flux regulator, different tuning procedures are used for induction motors and synchronous motors.

Induction Motor Flux Regulator

The tuning of the flux regulator for an induction motor is determined by three parameters:

1. Flxreg bandwidth in "P Flux Control"
2. L magnetizing in "P Motor Model"
3. T rotor in "P Motor Model"

"Flxreg bandwidth" should be set to the default value for almost all applications. "L magnetizing" and "T rotor" are usually unknown and must be measured. Both of these motor parameters change substantially with different operating conditions, but the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters in the "P Flux Control" group:

1. Base speed
2. Flux command base speed

Note: A third parameter, "Flux command zero speed", present in firmware revisions prior to 4.55 has been deleted.

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator Autotuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed and sets the flux command parameter to this value.

Flux Regulator Autotuning

The flux regulator is tuned with the motor running at constant speed using the following procedure:

1. Ensure that parameters "Rated motor rpm" in "P Nameplate" and "L total leakage" in "P Motor Model" are set to the correct value.
2. Set parameter "Autotune select" in "P Autotune" to 6.
3. Start the drive. The motor accelerates normally up to the speed specified by parameter "Autotune spd cmd". The motor magnetizing inductance is calculated from the measured current and flux feedback and parameter "Autotune Lm" is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux command stabilize. The drive then performs a normal stop.

Parameter "Autotune Lm" is set to the measured magnetizing inductance and parameter "Autotune select" is set to zero. Parameter "Flux Command Base Speed" in "P Flux Control" is set to a value which is intended to produce rated voltage at rated speed and load. The value of parameter "Autotune T rotor" is calculated from parameters "L magnetizing" and "Rated Motor rpm" (which gives the rated slip).

If the flux regulator Autotuning is successful, then parameter "L magnetizing" in "P Motor Model" is set equal to "Autotune Lm", parameter "T rotor" in "P Motor Model" is set equal to "Autotune T rotor", and the flux regulator gains are recalculated. If the flux regulator Autotuning fails then parameters "L magnetizing" and "T rotor" are not changed and a warning is issued indicating the cause of the failure.

L magn low - indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. This may occur if the motor is much larger than the drive and the nameplate parameters do not correspond to the actual motor ratings. In this case, the measured magnetizing inductance is probably correct and parameter "L magnetizing" should manually be set equal to "Autotune Lm".

L magn high - indicates that the measured value of magnetizing inductance is greater than 10.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. This may occur if the motor is much smaller than the drive and the nameplate parameters do not correspond to the actual motor ratings. The flux regulator should be tuned using the manual method described below.

T rotor low - indicates that the calculated value of rotor time constant is less than 0.2 seconds. This is caused by a value of "L magnetizing" or "Rated motor rpm" which is too low.

T rotor high - indicates that the calculated value of rotor time constant is greater than 5.0 seconds. This is caused by a value of "L magnetizing" or "Rated motor rpm" which is too high.

Flux Regulator Manual Tuning

1. Adjust the speed command to a value between 20 and 30 Hz.
2. Start the drive and wait for it to accelerate to the commanded speed.
3. Record the value of parameter " L magn measured " in "P motor Model".
4. Stop the drive.
5. Set parameter " L magnetizing " in "P Motor Model " to the recorded value of " L magn measured"
6. Calculate an approximate value of the rotor time constant using the following formula :

$$T_{\text{rotor}} = \frac{\text{L magnetizing}}{\text{Rated slip in rad/sec}}$$

Where

$$\text{Rated slip in rads /sec} = 2\pi f \times \frac{(\text{synchronous speed in rpm} - \text{rated speed in rpm})}{\text{synchronous speed in rpm}}$$

Set the parameter "T rotor" in "P Motor Model" to the calculated value.

Synchronous Motor Flux Regulator

This section applies only to firmware revision 5.10 and higher.

Before the flux regulator can be tuned, the analog output for the field current reference must be set up.

Configuring the Field Current Reference

Excitation for the synchronous motor is provided by a current regulated field supply, either a dc supply for a slip ring machine, or a three phase ac supply for a brushless machine. The drive provides an analog current reference as an input to the field supply. The analog current reference has a range of 0-10V, where 0V corresponds to zero field current and 10V corresponds to maximum field current. The scale and offset of the analog current reference must be adjusted to achieve a linear relationship between the current reference and the actual field current. If this is not done, the flux regulator may be unstable. The scale and offset of the analog output can be adjusted using the following procedure:

1. Assign variable "I field command" in "V Flux Control" to the analog output used to control the field supply (normally analog output 4L)
2. Set the analog output scale parameter (e.g. Analog Scale 4L) in "P Analog Output" to:
$$\text{Analog Scale} = \text{maximum analog input of field supply} / 10V$$
3. Set the analog output offset parameter (e.g. Analog Offset 4L) in "P Analog Output" to its maximum value of 9.92V. Confirm that the analog output variable (e.g. Analog Output 4L) in "V Analog I/O" is at its maximum value of 9.92V. Confirm that the reference input of the field supply is also at its maximum value.
4. Start the field supply and confirm that the field current goes to its maximum value. If necessary, adjust the field supply to achieve a field current slightly above rated. When the desired field current has been achieved, set the analog output offset back to 0.00V.

CAUTION: Applying maximum field current to a stationary machine for an extended period may damage the exciter. Adjust the current as quickly as possible.

5. Adjust the analog output offset to a level at which the field supply just begins to supply current. This compensates for any offset in the field supply current reference input.
6. Repeat steps 3 to 5 until the correct scale and offset adjustments are obtained.
7. Stop the field supply. The setup of the field current reference is complete and you can proceed with the tuning of the flux regulator.

Tuning the Flux Regulator

The tuning of the flux regulator for a synchronous machine is determined by four parameters:

1. Flxreg bandwidth in "P Flux Control"
2. L magnetizing in "P Motor Model"
3. T rotor in "P Motor Model"
4. Lmd in "P Motor Model"

"Flxreg bandwidth" should be set to the default value for almost all applications. "L magnetizing", "Lmd", and "T rotor" are usually unknown and must be measured. Although these motor parameters change with different operating conditions, the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters in the "P Flux Control" group:

1. Base speed
2. Flux command base speed

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator autotuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed and sets the flux command parameter to this value.

Flux Regulator Autotuning

Note: If a position encoder is fitted to the motor, the flux regulator autotuning is performed with the encoder feedback turned off because it is assumed that the encoder has not been aligned with the rotor axis yet. Since less starting torque is produced with the encoder feedback off, this test should be performed with reduced load. The encoder offset measurement is also most accurate with no load on the motor.

The flux regulator is tuned with the motor running at constant speed using the following procedure:

1. Ensure that the analog reference for the field current has been set up as described previously, and that parameter "L total leakage" has been set to the correct value.
2. Set parameter "Autotune select" in "P Autotune" to 6.
3. Start the drive. The motor accelerates normally up to the speed specified by parameter "Autotune spd cmd". The motor magnetizing inductance is calculated from the magnetizing current reference and the flux feedback and parameter "Autotune Lm" is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux command stabilize. If a position encoder is fitted to the motor, the angle between the measured flux and the encoder zero is measured and parameter "Encoder offset" is adjusted to align the encoder with the motor flux.
4. The field current reference is then held constant and the response of the flux to changes in stator magnetizing current is measured by stepping "Ix command" up and down at regular intervals. The size of the step in the stator current is specified by parameter "Autotune lsd step". The step response measurement takes about 3 minutes. When the measurement is complete, the drive performs a normal stop.

Parameter "Autotune Lm" is set to the measured magnetizing inductance and parameter "Autotune select" is set to zero. Parameter "Flux Command Base Speed" in "P Flux Control" is set to a value calculated to produce rated voltage at rated speed and load. The value of parameters "Autotune T rotor" and "Autotune Lmd" are calculated from the step response data.

If the flux regulator Autotuning is successful, then parameter "L magnetizing" in "P Motor Model" is set equal to "Autotune Lm", parameter "T rotor" in "P Motor Model" is set equal to "Autotune T rotor", and parameter "Lmd" in "P Motor Model" is set equal to "Autotune Lmd". If the flux regulator autotuning fails then parameters "L magnetizing", "Lmd", and "T rotor" are not changed and a warning is issued indicating the cause of the failure.

L magn low - indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.

L magn high - indicates that the measured value of magnetizing inductance is greater than 10.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.

T rotor low - indicates that the calculated value of rotor time constant is less than 0.1 seconds

T rotor high - indicates that the calculated value of rotor time constant is greater than 5.0 seconds.

7. Speed Regulator

The tuning of the speed regulator is determined by two parameters in the "P Speed Control" group:

1. Spdreg bandwidth
2. Total inertia

Parameter "Spdreg bandwidth" is set to a value determined by the requirements of the application, but parameter "Total inertia" is usually unknown and must be measured.

Speed Regulator Autotuning

The Autotuning determines the total inertia by measuring the change in speed that occurs when a low frequency sinusoidal torque perturbation is applied to the motor. This method of measuring inertia was introduced in firmware Rev 4.72/5.20. Previous revisions of firmware used a different method. The inertia measurement is not affected by the load torque as long as the drive does not hit torque limit. Do not disconnect the driven load from the motor, as it is the total inertia of motor and load that is being measured. The following procedure should be used:

1. Ensure that parameters "Autotune spd cmd" and "Autotune trq stp" in "P Autotune" are set to suitable values.
2. Set parameter "Autotune select" in "P Autotune" to 7.
3. Start the drive. The motor accelerates normally up to the speed specified by parameter "Autotune spd cmd". When the motor speed has settled at the commanded value, a sinusoidal perturbation specified by parameter "Autotune trq stp" is added to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the total inertia. The torque perturbation is then removed and the drive performs a normal stop.

Parameter "Autotune inertia" is set to the measured inertia and parameter "Autotune select" is set to zero. If the test is successful, parameter "Total inertia" in "P Speed Control" is set equal to "Autotune inertia" and the speed regulator gains are recalculated. If the test fails then parameter "Total inertia" is not changed and a warning is issued indicating the cause of the failure:

Reg in limit - indicates that the torque command was greater than "Torque limit motoring" or "Torque limit braking". The measured inertia value is invalid. Parameter "Autotune trq stp" or parameter "Autotune spd cmd" must be set to a lower value and the test repeated.

Tuning abort - indicates that the deviation in motor speed was greater than 10 Hz. The measured inertia value is invalid. Parameter "Autotune trq stp" must be set to a lower value and the test repeated.

Inertia high - indicates that the measured total inertia was greater than 5 seconds. This warning is intended to draw attention to an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result and parameter "Total inertia" should be manually set equal to "Autotune inertia". However, a high inertia measurement could also be produced by a value of "Autotune trq stp" which is too low.

Speed Regulator Manual Tuning

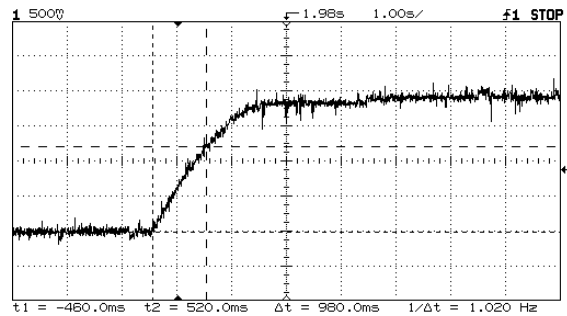
If it is not possible to tune the speed regulator using the autotune function, then the step response of the speed regulator can be tuned manually using the following procedure. To obtain accurate results, the load torque must be steady.

1. Set parameter "Spdreg bandwidth" in "P Speed Control" to 1.0 rad/sec.

SELECT: P Speed Control			1 of 2
Spdreg bandwidth	1.0	r/s	
Total inertia	1.00	sec	
Trq rate limit	.33	pu	
Trq lmt motoring	.90	pu	
Trq lmt braking	.70	pu	
Trq command 0	.15	pu	
Trq command 1	.15	pu	
Speed ref step	.0	Hz	
ALARMS			
NEXT PG			
PREV PG			
EXIT			

Speed Control Parameter Screen

2. Set parameter "Total inertia" in "P Speed Control" to an initial value of 1.0 sec.
3. Assign variable "Speed error" in "V Speed Control" to one of the line converter analog outputs (1 to 4) and display it on a digital storage oscilloscope set to 2 V/division vertical and 1 sec/division horizontal. These variables may be assigned the same way the external meters were assigned.
4. Adjust the speed command to a value around the middle of the operating speed range.
5. Start the drive and wait for it to accelerate to the commanded speed.
6. Set parameter "Speed ref step" in "P Speed Control" to 0.8 Hz. The drive speed will step up and down by this amount at regular intervals. The step of 0.8 Hz corresponds to 4 V on the analog output. Since the speed error signal has a range of only 4 Hz in order to achieve the required resolution for small changes in speed, the signal may sometimes rollover (jump from +10V to -10V) during the speed step. If this occurs, it can be eliminated by adjusting the speed command up or down slightly.
7. Adjust the value of parameter "Total inertia" until the speed rises to approximately 63% of its final value in 1 second as shown in the figure. If the response time is too fast it indicates that "Total inertia" is set too high and should be decreased. If the response is too slow then "Total inertia" is set too low and should be increased.



CORRECTLY TUNED SPEED REGULATOR

8. Set parameter "Spdreg bandwidth" to the normal operating value. Confirm that the response time is equal to the inverse of the speed regulator bandwidth and that there is minimal overshoot. For example, if the speed regulator bandwidth is set to 2 rad/sec, the speed should rise to 63% of its final value in 0.5 second.
9. Set parameter "Speed ref step" to zero and stop the drive.

Calculating Total Inertia

If the system inertia cannot be measured, it can be calculated if the moment of inertia of the motor and load are known. The value of parameter "Total inertia" is defined as the time required to accelerate the motor and load to rated speed when rated torque is applied. It can be calculated using the following formula:

$$\text{Total inertia} = \frac{\text{total inertia of motor \& load in kg-m}^2 \times (\text{rated speed in rad/ sec})^2}{\text{rated power in watts}}$$

or

$$\text{Total inertia} = 6.21 \times 10^{-7} \frac{\text{total inertia of motor and load in lb-ft}^2 \times (\text{rated speed in rpm})^2}{\text{rated power in hp}}$$

If there is a gearbox between the motor and load, the inertia of the load must be referred to the motor side of the gearbox.

8. Flux Regulator and Speed Regulator

It is possible to tune the flux regulator and speed regulator at the same time using the following procedure:

1. Set parameter "Autotune select" in "P Autotune" to 8.
2. Start the drive. The flux regulator autotuning is performed, and if this is successful, the speed regulator autotuning is also performed without stopping. If the flux regulator autotuning is not successful then the autotuning of the speed regulator is not performed. In either case, when the test is complete the drive performs a normal stop.

The tests performed are the same as described previously for the flux regulator and speed regulator autotuning.

Application Setup

Once the drive has been tuned, it will be necessary to configure the drive for operation in its environment. There are several parameters associated with the use of the drive for specific applications. See the Functional description in Chapter 5 for more information involving setting of the acceleration and deceleration profiles and other individual functions.

Saving Parameters

Save all parameters as entered into the drive E² memory. In case of a power failure parameters will be reloaded from non-volatile memory.

To save the parameters entered, press "EEPROM" (F9) softkey from the top level menu. The screen in the figure will be displayed. Press the "SAVE" (F5) softkey.

EEPROM:				
Operation:				
Operation Status:				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

From this screen, if you press the "YES" (F8) softkey you will overwrite the EEPROM memory with the loaded parameters in memory.

EEPROM:				
Operation: SAVE TO EEPROM				
PROCEED? Yes/No?				
Operation Status: SAVE PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

This screen shows a successful save. Press the "EXIT" (F10) softkey to return to the top level main menu. For more information on this subject, see the interface terminal section on save/retrieve of drive parameters in Chapter 7.

EEPROM:				
Operation: SAVE TO EEPROM				
Operation Status: COMPLETED				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

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Introduction

This chapter will assist the user in the troubleshooting of a Bulletin 1557 drive. This chapter contains reference material with information regarding:

- Printed circuit card replacement
- Power semiconductor testing
- Power Semiconductor replacement



WARNING: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.



CAUTION: The CMOS devices used on the control circuit boards can be destroyed or damaged by static charges. If personnel will be working near static sensitive devices, they must be appropriately grounded.

Recommended Tools and Equipment

The following list of tools is highly recommended for fault tracing and repair of a 1557 Medium Voltage Drive.

- Oscilloscope with memory (dual channel 100 Megahertz)
- Multimeter with assorted clip leads
- Assorted hand tools, with standard inch and metric sockets and wrenches.
- Approved contact type hot stick with appropriate high voltage (5kV minimum) gloves.
- Anti-Static wrist strap
- Chip extractor

Documenting Shutdowns

Any faults, warnings, or messages displayed on panel view should be thoroughly documented by the user prior to reset those messages. This will assist maintenance personnel in correcting problems and ensuring they do not recur.

Printed Circuit Card Replacement

The replacement of printed circuit boards should be handled in a careful and deliberate manner. There are some precautions that should be taken.

- Remove all power to the drive.
 - Do not remove the replacement board from the anti-static bag, until necessary.
 - Use anti-static wrist strap.
1. Note the location and orientation of the ribbon cables and carefully detach them.
 2. Remove all screws or extract the board from the plastic holders. Be especially careful not to drop any screws or washers into other circuits or devices. It is necessary to cover these devices.
 3. Remove the board. Remove the replacement board from the anti-static bag. Ensure the replacement board is of the correct type before re-installing. Confirm that any adjustments to the new boards are made prior to putting the drive back in service. Put the defective board in the anti-static bag.
 4. Retest the board to verify the installation was successful. Confirm the proper revision level of memory in the control boards.
 5. If the board is to be returned for repair or exchange, contact your local Rockwell Automation service representative to obtain a RA# (return authorization number). Attach this number and a description of the problem, to facilitate quick turnaround of the repair.

Line Side Control Board Replacement

The following procedure must be followed when the Line Side Drive Control Board (80165-018-51) is replaced.

1. Record the drive setup: **A)** complete parameter list, **B)** fault masks, **C)** fault messages, and **D)** PLC links. This should be done on a drive commissioning form or with the use of the door mounted drive printer (if the drive has this option). If this information can not be accessed from the drive due to a severely damaged Line board this information should be available from the customers copy of the commissioning form.



CAUTION: The CMOS devices used on the control circuit boards can be destroyed or damaged by static charges. If personnel will be working near static sensitive devices, they must be appropriately grounded.

2. Isolate the drive from medium voltage incoming line. Power down the drive control power, replace the Line Side control board. The Firmware chips located in U12 and U13 must be on the same Rev. level as the firmware located in the Machine Side control board. If the firmware is not identical or is not present (replacement boards are not supplied with firmware) remove the firmware from the old board and install it in the new board, insuring that the orientation and the location of the chips are correct.
3. Power up the drive control power, both green Healthy LEDs should illuminate and stay illuminated with no flicker.

```

REV 2.20
      ALLEN-BRADLEY
      BULLETIN 1557 MV DRIVE

Status: NOT READY  Speed:      0 RPM
          Current:      0 A
Faults:  0          Voltage:    0 V
Warnings: 0          Power:     0 KW
    
```

HELP	UTILITY	PRINT	DISPLAY	EEPROM
ALARMS	STATUS	SETUP	DIAGS	ACCESS

4. From the main screen press function key F5 (EEPROM).

```

EEPROM:

      Operation:

      Operation Status:
    
```

HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

5. Press function key F3 (INIT). If nothing happens when you press F3, you do not have unrestricted access. Return to the main menu, go to the access screen, and enter the password to enable this function.

```

EEPROM:

      Operation: INITIALIZE
      PROCEED? Yes/No?
      Operation Status:
      INITIALIZE PENDING
    
```

HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

6. Press function key F8 (YES). The drive control will initialize to the default parameters.

EEPROM:				
Operation: INITIALIZE				
Operation Status: COMPLETED				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

7. Ensure that the message reads completed and not failed. If you encounter a failed message retry the initialize.

EEPROM:				
Operation: SAVE TO EEPROM				
PROCEED? Yes/No?				
Operation Status: SAVE PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

8. Save the default parameters to EEPROM memory. If you do not, the initialized parameters will not be saved permanently and the next time power is cycled these new parameters will be lost..

EEPROM:				
Operation: SAVE TO EEPROM				
Operation Status: COMPLETED				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

9. Press the F8 function key (YES) to acknowledge the save. Ensure that the operation status is completed and not failed. If you get a failed message retry the save operation.

10. Turn the drive control power off. Wait 15 seconds. Turn the power back on. Cycling the control power resets some internal variables which only happens on power up.

11. Reload the original parameters being careful to correct any parameters that have changed.

12. Save the parameters to EEPROM.

13. Cycle power again and RECHECK the displayed parameters with the original list.

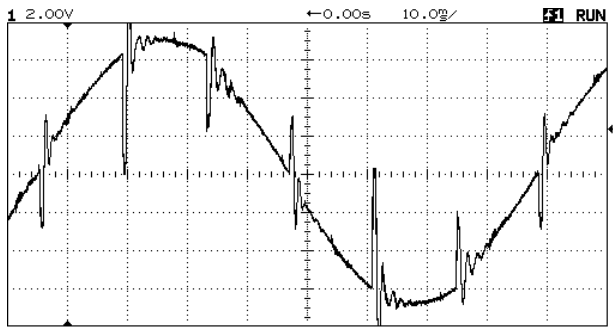
BULLETIN 1557 LINE SIDE (DCB2) and MACHINE SIDE (DCB1) CONTROL BOARD OSCILLOSCOPE MONITORING TEST POINTS

CONNECTION	LINE SIDE CONTROL BOARD	MACHINE SIDE CONTROL BOARD
V12 / TP1	LINE VOLTAGE, VAB	MOTOR VOLTAGE, VAB
V23 / TP2	LINE VOLTAGE, VBC	MOTOR VOLTAGE, VBC
V31 / TP3	LINE VOLTAGE, VCA	MOTOR VOLTAGE, VCA
VDC / TP4	DC LINK VOLTAGE	DC LINK VOLTAGE
F12 / TP5	RECONSTRUCTED LINE VOLTAGE	MOTOR FLUX
F23 / TP6	RECONSTRUCTED LINE VOLTAGE	MOTOR FLUX
F31 / TP7	RECONSTRUCTED LINE VOLTAGE	MOTOR FLUX
FLX / TP8	RECTIFIED LINE VOLTAGE	RECTIFIED MOTOR FLUX
I1 / TP9	LINE CURRENT, Phase A	MOTOR CURRENT, Phase A
I2 / TP10	LINE CURRENT, Phase B	MOTOR CURRENT, Phase B
I3 / TP11	LINE CURRENT, Phase C	MOTOR CURRENT, Phase C
IDC / TP12	DC LINK CURRENT	RECTIFIED MOTOR CURRENT
VNG / TP13	LINE NEUTRAL TO GRD VOLTAGE	MOTOR NEUTRAL TO GRD VOLTAGE
AO1 / TP14	ASSIGNABLE ANALOG OUTPUT	ASSIGNABLE ANALOG OUTPUT
AO2 / TP15	ASSIGNABLE ANALOG OUTPUT	ASSIGNABLE ANALOG OUTPUT
AO3 / TP16	ASSIGNABLE ANALOG OUTPUT	ASSIGNABLE ANALOG OUTPUT
AO4 / TP17	ASSIGNABLE ANALOG OUTPUT	ASSIGNABLE ANALOG OUTPUT
COM / TP18	ANALOG COMMON	ANALOG COMMON

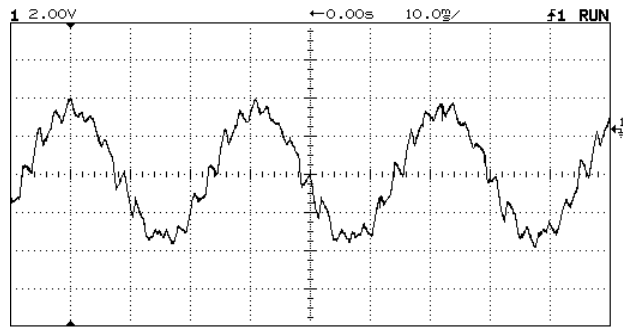
NOTE: All test points are referenced to ground, the scope common must be connected to cabinet ground.

V12 / TP1, V23 / TP2, V31 / TP3, VNG / TP13	Approximately 5 volts RMS nominal
VDC / TP4	Approximately 6.75 volts nominal
F12 / TP5, F23 / TP6, F31 / TP7	Approximately 5.32 volts RMS nominal
FLX / TP8	Approximately 7.53 volts peak nominal
I1 / TP9, I2 / TP10, I3 / TP11, IDC / TP12	Approximately 5 volts peak nominal

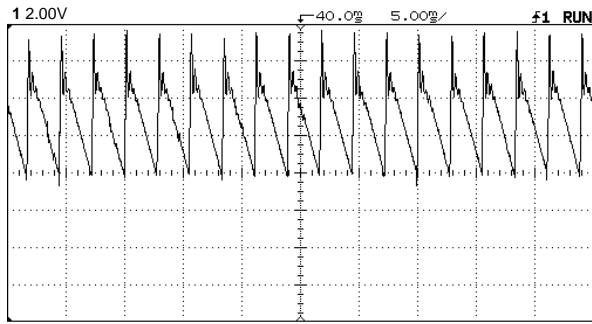
Test Point Waveforms



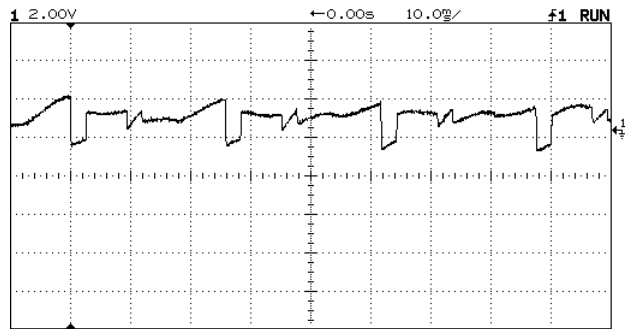
LINE SIDE CONTROL BOARD
V12 / V23 / V31 Line Voltage
 50% Speed 25% Torque



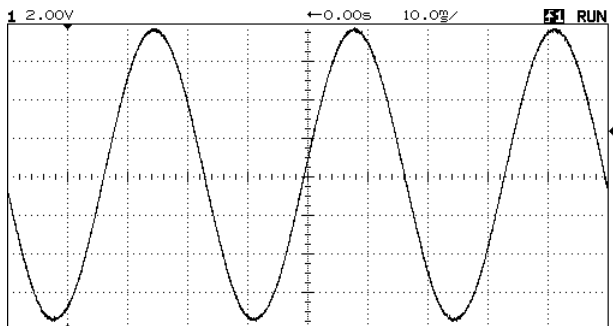
MACHINE SIDE CONTROL BOARD
V12 / V23 / V31 Line Voltage
 50% Speed 25% Torque



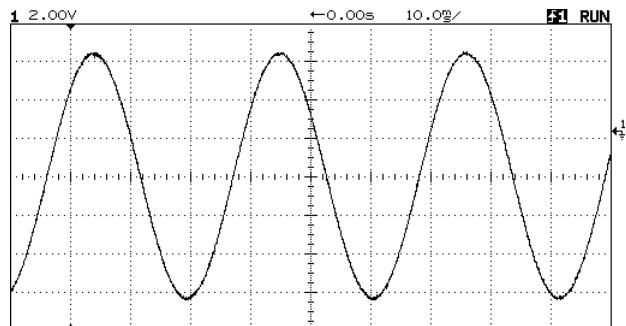
LINE SIDE CONTROL BOARD
VDC DC Link Voltage
 50% Speed 25% Torque



MACHINE SIDE CONTROL BOARD
VDC DC Link Voltage
 50% Speed 25% Torque

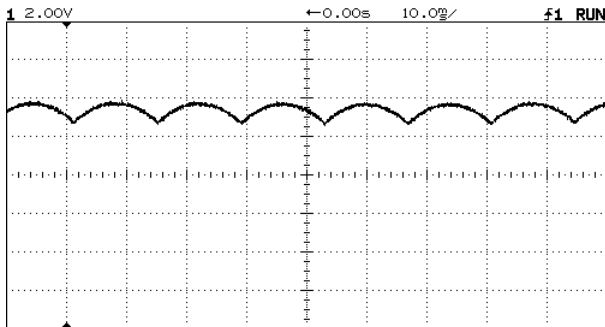


LINE SIDE CONTROL BOARD
F12 / F23 / F31 Reconstructed Line Voltage
 50% Speed 25% Torque

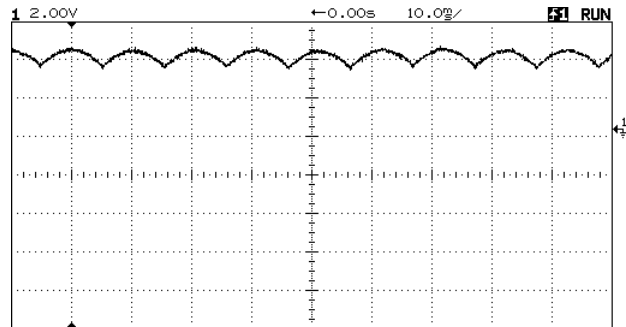


MACHINE SIDE CONTROL BOARD
F12 / F23 / F31 Motor Flux
 50% Speed 25% Torque

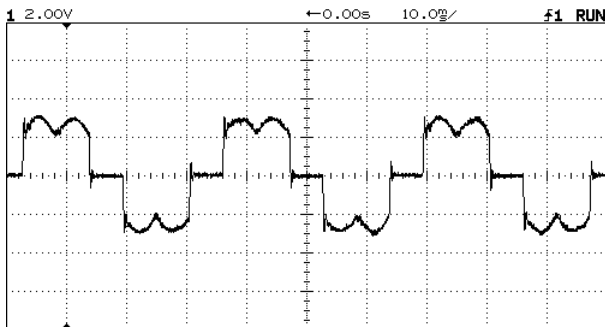
Test Point Waveforms



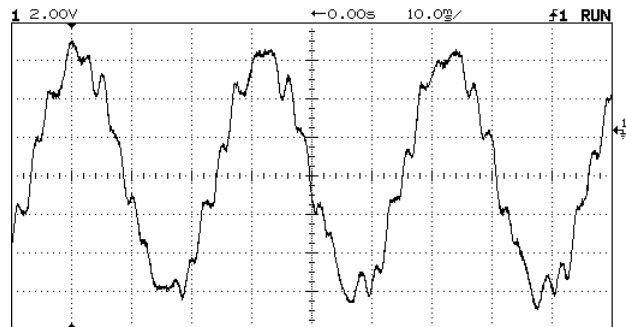
LINE SIDE CONTROL BOARD
FLX Rectified Line Voltage
 50% Speed 25% Torque



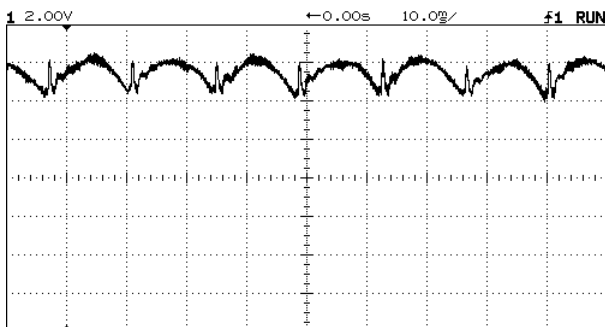
MACHINE SIDE CONTROL BOARD
FLX Rectified Motor Flux
 50% Speed 25% Torque



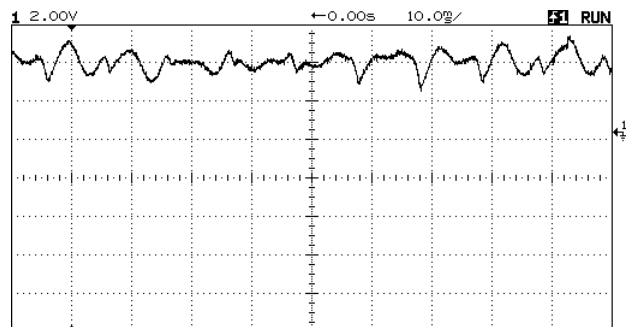
LINE SIDE CONTROL BOARD
I1 / I2 / I3 Line Current
 50% Speed 25% Torque



MACHINE SIDE CONTROL BOARD
I1 / I2 / I3 Motor Current
 50% Speed 25% Torque



LINE SIDE CONTROL BOARD
IDC DC Link Current
 50% Speed 25% Torque



MACHINE SIDE CONTROL BOARD
IDC Rectified Motor Current
 50% Speed 25% Torque

Firmware Change-out Procedure

The following procedure must be followed when the drive firmware is replaced or being upgraded.

1. Record drive setup, complete parameter list and fault masks, PLC links, and external faults messages of original drive setup. This should be done on one of the commissioning forms or with a drive printer (if the drive has that option).
2. Refer to the compatibility chart provided to ensure that the communication processor and DCB boards have the necessary firmware revisions.
3. Power down the drive. Use anti-static wrist strap and then remove the chips located in U12 and U13 of each Digital Control Board (DCB) and communication processor board. Removal of these chips should be done using the appropriate removal tool (chip extractor). One vendor for the removal tool is AUGAT.
4. Install the new chips. Ensure that the orientation of the chips is correct in the socket. Also ensure the correct chip is inserted into the correct socket, U12 should have a -12 chip.
5. Power up the unit, all green HEALTHY lights should come on, and stay on with no flicker, on DCBs and communication processor boards.

REV 2.20				
ALLEN-BRADLEY BULLETIN 1557 MV DRIVE				
Status: NOT READY	Speed:	0 rpm		
Faults: 0	Current:	0 A		
Warnings: 0	Voltage:	0 V		
	Power:	0 kW		
HELP	UTILITY	PRINT	DISPLAY	EEPROM
ALARMS	STATUS	SETUP	DIAGS	ACCESS

6. From the main screen press function key F5 (EEPROM).

EEPROM:				
Operation:				
Operation Status:				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

7. Press function key F3 (INIT). If nothing happens when you press F3, you do not have unrestricted access. Return to the main menu, go to the access screen, and enter the password to enable this function.

EEPROM:				
Operation: INITIALIZE				
PROCEED? Yes/No?				
Operation Status: INITIALIZE PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

8. Press function key F8 (YES). The drive control boards will initialize to the default parameters.

EEPROM:				
Operation: INITIALIZE				
Operation Status: COMPLETED				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

9. Ensure that the message on Panelview reads Operation Status as completed and not failed. If you encounter a failed message retry the initialize.

EEPROM:				
Operation: SAVE TO EEPROM				
PROCEED? Yes/No?				
Operation Status: SAVE PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

10. Enter all the data recorded in step 1 above. Save the parameters to EEPROM memory. If you do not, the drive parameters will not be saved permanently and the next time power is cycled these new parameters will be lost.

EEPROM:				
Operation: SAVE TO EEPROM				
Operation Status: COMPLETED				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

11. Press the F8 function key (YES) to acknowledge the save. Ensure that the operation status is completed and not failed. If you get a failed message retry the save operation.

12. Turn the drive control power off. Wait 15 seconds. Turn the power back on. Cycling the control power resets some internal variables, which only happens on power up.
13. Re-verify that all the loaded original parameters carefully and correct any parameters which have not been entered or been added in the new software revision. This information will be found in the software release notes.
14. Make sure to save the parameters to EEPROM.

Power Semiconductor Testing

If you suspect that a problem may exist with a power semiconductor follow the steps below to help identify a suspicious device.



WARNING: Before attempting any work, verify the system has been locked out and tested to have no potential.

- Using an ohmmeter, measure the anode to cathode, anode to gate, and cathode to gate. The resistance in circuit will differ from out of circuit where other assemblies provide a parallel path.

DEVICE	TEST POINTS	EXPECTED MEASUREMENT
GTO	ANODE TO CATHODE	10.3K Ω
	ANODE TO GATE	10.3K Ω
	CATHODE TO GATE	10 Ω
SCR	ANODE TO CATHODE	23.5K Ω
	ANODE TO GATE	23.5K Ω
	CATHODE TO GATE	12 Ω
DIODE	ANODE TO CATHODE	10 Ω

Please note the actual resistance measurement will depend upon the device and the ohmmeter used. It is not possible to accurately measure unclamped semiconductor devices.

- If a short is found isolate the device on the stack and verify that indeed the device is faulty, only then proceed with removing the stack from the drive.
- If the semiconductor device is not suspected of being faulty, test other surrounding components, or call your local RA/AB service representative for assistance.

Thyristor Clamps

Thyristor clamps are used to maintain the required contact force for the power semi-conductors. A pre-calibrated force is exerted on the contact area of the semi-conductors, The force is exerted by a pre-set load in the stack of disc springs at the head of the clamp. There are three different clamps used in each 1557 drive:

SNUBBER DIODE
MACHINE SIDE CONVERTER STACK
LINE SIDE CONVERTER STACK

Quantity of clamps voltage dependent.
Quantity of clamps = 6
Quantity of clamps = 3

SCR Gate Driver Board Calibration and Gate Pulse Verification Procedure

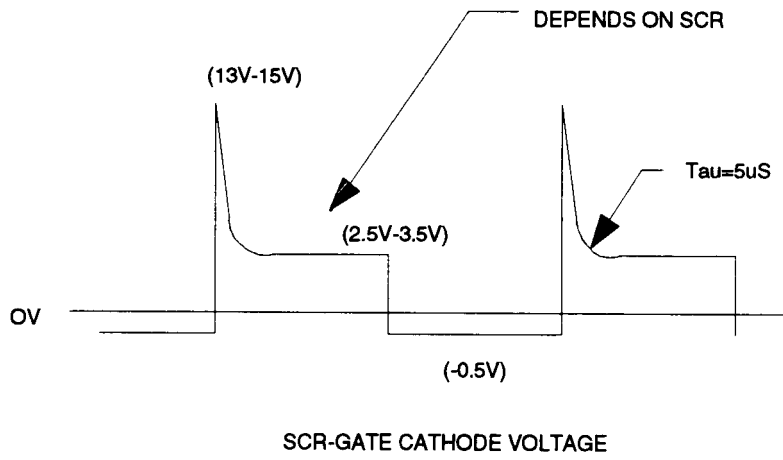
The following procedure must be followed when the Silicon Controlled Rectifier Gate Driver (SCRGD) and/or isolated Gate Driver Power Supply (IGDPS) boards are replaced. This procedure must also be followed whenever LINE SIDE CONVERTER devices are to be replaced.

Tools Required: Digital Multimeter
 100 Meg Hz Oscilloscope
 Minigrabber meter probes
 Potentiometer Screwdriver

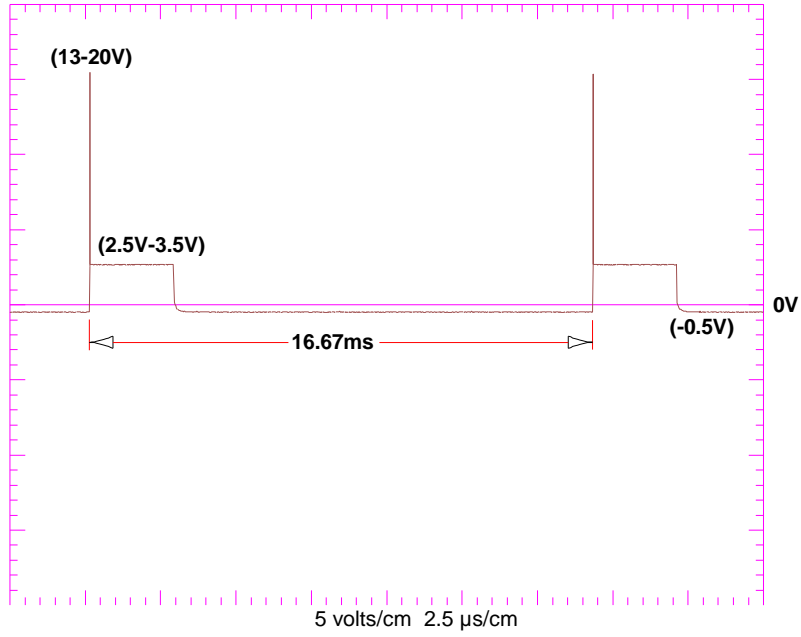
1. Close the circuit breaker in the drives control logic section to apply the 50 volts DC power to the Isolated Gate Driver Power Supply Board (IGDPS). The green LED on the Gate Driver should illuminate. If the LED does not illuminate check the followings:
 - 2A fuse on the GTOGD board
 - The connections from flyback transformer on IGDPS board to GTOGD board
 - 50 V DC at IGDPS board
 - The multi-turn potentiometer P1 is set to minimum value, the potentiometer is located at the center of IGDPS board.
 If all above is correct, replace the IGDPS board.
2. Wait 10 minutes for the board to warm-up and stabilize.
3. Connect the negative lead of the Multimeter to test point TP15 located on the lower right corner of the SCRGD board and connect the positive lead to test point TP4 located in the upper left corner of SCRGD board.
4. Adjust the multi-turn potentiometer P1 located in the center of the IGDPS board for the voltage range indicated in the table below.
5. Remove the positive meter lead from TP4 and connect it to adjacent test point TP3 of SCRGD board. Verify that the voltages within the voltage range indicated in the table below.

BOARD COMBINATION	POSITIVE RAIL @ TP4 to TP15	NEGATIVE RAIL @ TP3 to TP15
80165-178-52 with 80165-158-51/53/54	+22.50V to +23.00V	-5.0V to -6.0V
80165-698-52 with 80165-158-51/53/54	+22.50V to +23.00V	-5.0V to -6.5V

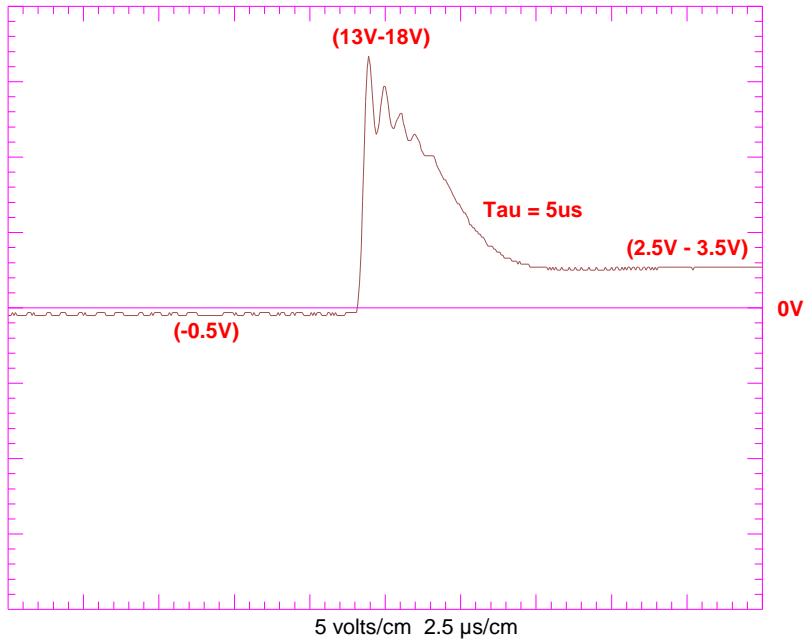
6. The board calibration is now complete.
7. Put the drive in TEST MODE 1 and start the drive.
8. Connect the oscilloscope probes to the gate and cathode terminals on the SCRGD board and verify the gate pulse waveform is as indicated in the example below.



Typical waveforms



SCR Gate to Cathode Voltage



SCR Gate to Cathode Firing Voltage

GTO Gate Driver Board Calibration and Gate Pulse Verification Procedure **(800 or 1500 Amp Devices)**

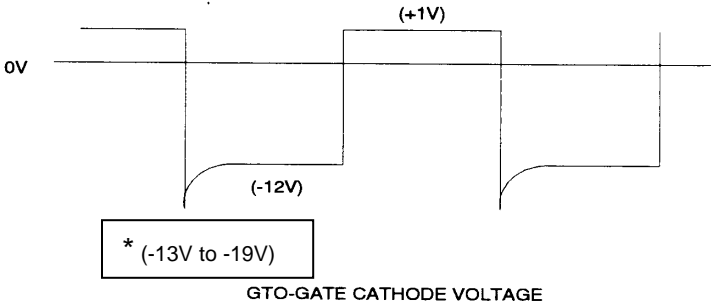
The following procedure must be followed when the GTOGD and/or IGDPS boards are replaced. This procedure must also be followed whenever MACHINE SIDE CONVERTER devices are replaced.

Tools Required: Digital Multimeter
 100 Meg Hz Oscilloscope
 Minigrabber meter probes
 Potentiometer Screwdriver

1. Close the circuit breaker in the drives control logic section to apply the 50 volts DC power to the Isolated Gate Driver Power Supply Board (IGDPS). The green LED on the Gate Driver should illuminate. If it does not illuminate, check the followings:
 - 2A fuse on the GTOGD board
 - The connections from flyback transformer on IGDPS board to GTOGD board
 - 50 V DC at IGDPS board
 - The multi-turn potentiometer P1 is set to minimum value, the potentiometer is located at the center of IGDPS board.
 If all above is correct, replace the IGDPS board.
2. Wait 10 minutes for the board to warm-up and stabilize.
3. Connect the negative lead of the Multimeter to test point TP15 located on the lower right corner of the GTOGD board and connect the positive lead to test point TP3 located in the upper left corner of GTOGD board.
4. Adjust the multi-turn potentiometer P1 located in the center of the IGDPS board for the voltage range indicated in the table below.
5. Remove the positive meter lead from TP3 and connect it to adjacent test point TP5 on GTOGD board. Verify that the voltages within the voltage range indicated in the table below.

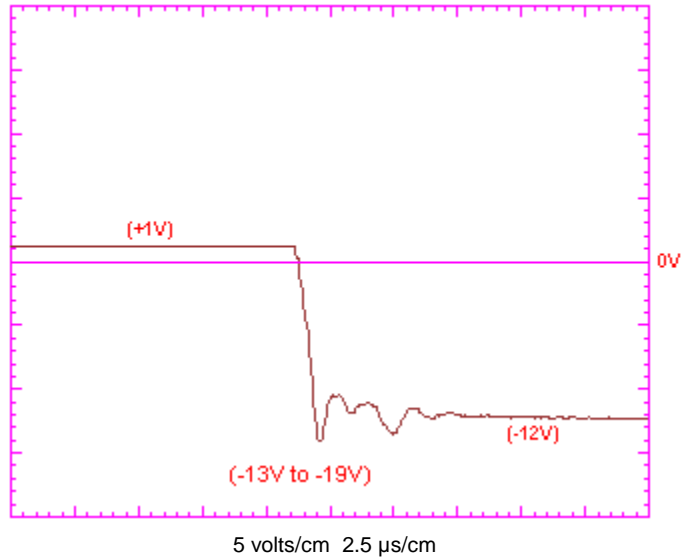
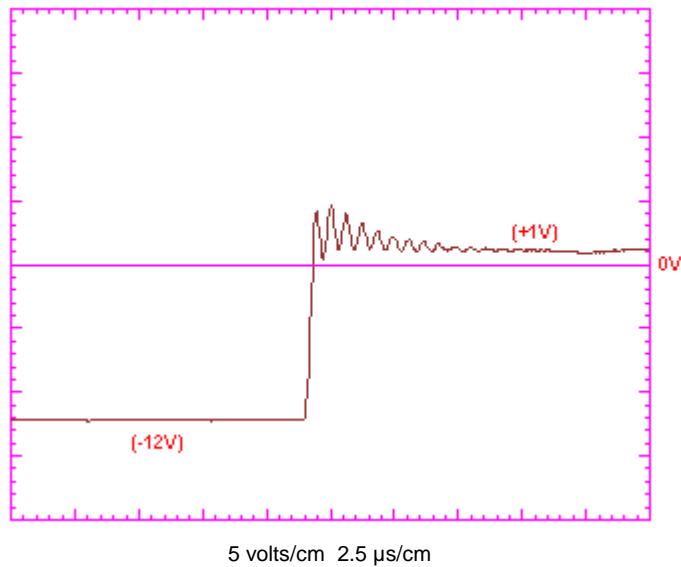
BOARD COMBINATION	POSITIVE RAIL @ TP5 to TP15	NEGATIVE RAIL @ TP3 to TP15
80165-178-51 with 80165-138-51/52/53/54	+7.5V to +8.8V	-12.45V to -12.55V
80165-698-51 with 80165-138-53	+7.5V to +9.0V	-12.45V to -12.55V
80165-698-51 with 80165-138-54	+7.5V to +10.0V	-12.45V to -12.55V

6. The board calibration is now complete.
7. Put the drive in TEST MODE 1 and start the drive.
8. Connect the oscilloscope probes to the gate and cathode terminals on the SCRGD board and verify the gate pulse waveform is as indicated in the example below.



Voltage levels revised Sept. 14, 1999

Typical waveforms

**GTO Turn-Off Gate to Cathode Firing Pulse****GTO Turn-On Gate to Cathode Firing Pulse**

GTO Gate Driver Board Calibration and Gate Pulse Verification Procedure
(3000 Amp Devices)

PART NUMBER COMBINATION **80165-958-53 (IGDPS)**
 80165-978-53 (GTOGD)

The following procedure must be followed when the GTOGD and/or IGDPS boards are replaced. This procedure must also be followed whenever MACHINE SIDE CONVERTER devices are replaced.

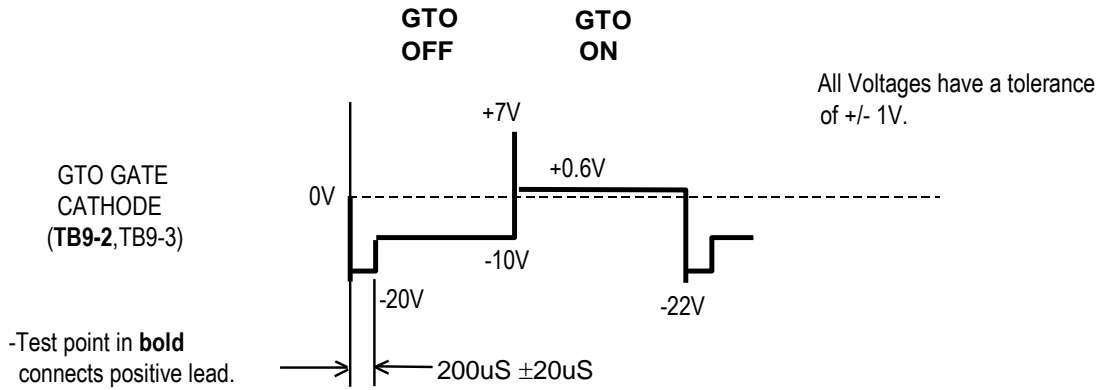
Tools Required: Digital Multimeter
 100 Meg Hz Oscilloscope
 Minigrabber meter probes
 Potentiometer Screwdriver

1. Close the circuit breaker in the drives control logic section to apply the 50 volts DC power to the Isolated Gate Driver Power Supply Board (IGDPS). The 2 green LEDs on the Gate Driver Board should illuminate.
2. The Driver Board is self-adjusting no physical calibration is required.
3. Connect the negative lead of the multimeter to test point TP18 and connect the positive lead of the multimeter test point TP17 on the GTOGD Board and verify the voltage is within the voltage range indicated in the table below.
4. Remove the leads from the test points.
5. Connect the negative lead of the multimeter to test point TP5 and connect the positive lead of the multimeter test point TP10 on the GTOGD Board and verify the voltage is within the voltage range indicated in the table below.
6. Remove the lead on TP10 and connect it to test point TP13 on the GTOGD Board and verify the voltage is within the voltage range indicated in the table below.

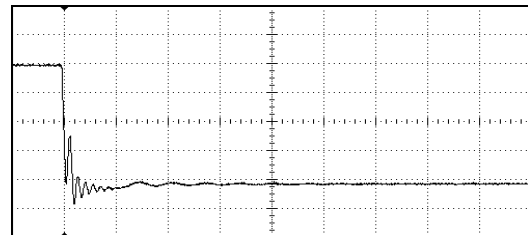
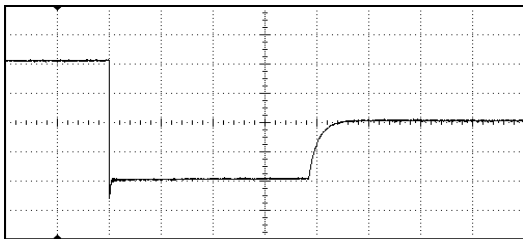
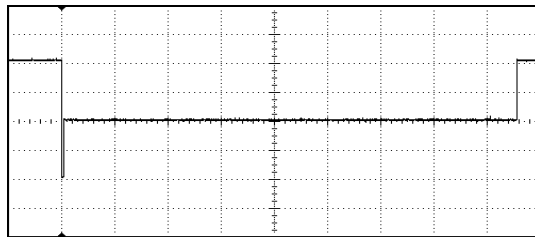
BOARD COMBINATION <u>80165-958-53 with 80165-978-53</u>	POSITIVE RAIL @ TP17 to TP18 +12.50V to 13.50V	NEGATIVE RAIL @ TP13 to TP5 -19.70V to -20.30V
	POSITIVE RAIL @ TP10 to TP5 +7.80V to +8.20V	

7. Put the drive in TEST MODE 1 and start the drive.
8. Connect the oscilloscope probes to the gate and cathode terminals on the SCRGD board and verify the gate pulse waveform is as indicated in the example on the next page.

The gate-cathode voltage during gating of a 3000A GTO



Actual waveforms at different time bases.



Checking Clamp Force

Clamps should be periodically tested to determine that the required forces are being exerted.

SNUBBER DIODE

There is a tabwasher underneath the nylon insert locknut. The tabwasher should just be able to turn with finger touch (see Figure 10.1).

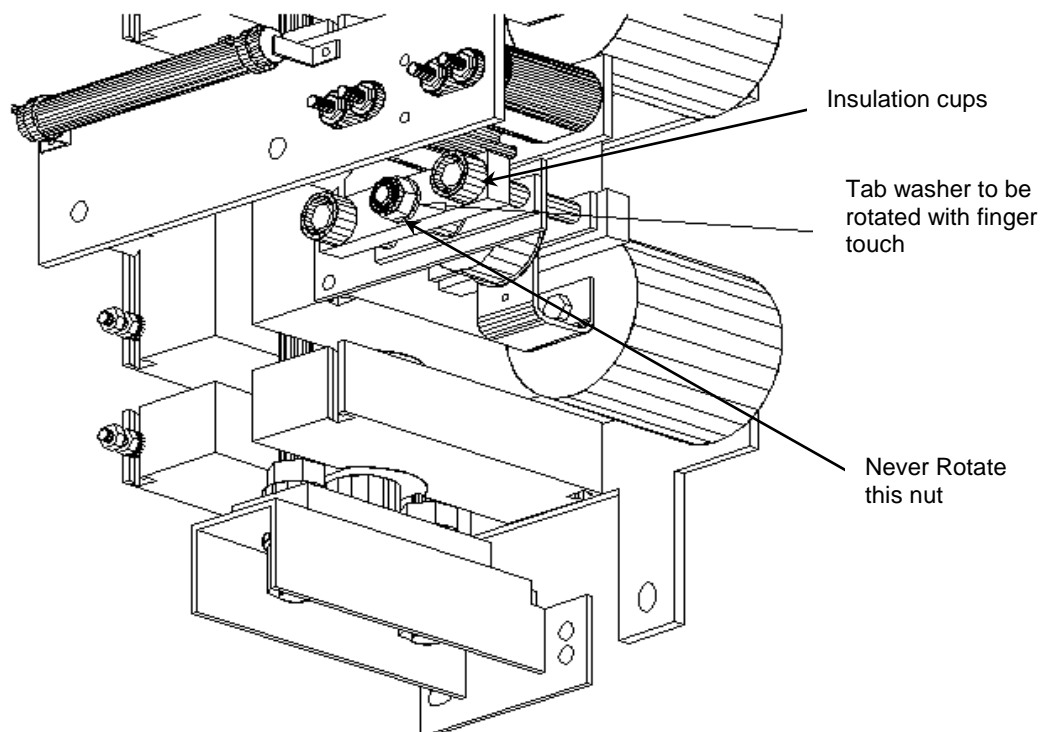


Figure 10.1 – Checking Clamp Force – Snubber Diode

MACHINE SIDE CONVERTER AND LINE SIDE CONVERTER

There are two disc springs located top and center of the clamp pressure bar assembly (not to be confused with the larger diameter disc springs below the pressure bar assembly). The disc springs should just be able to turn with finger touch (see Figure 10.2).

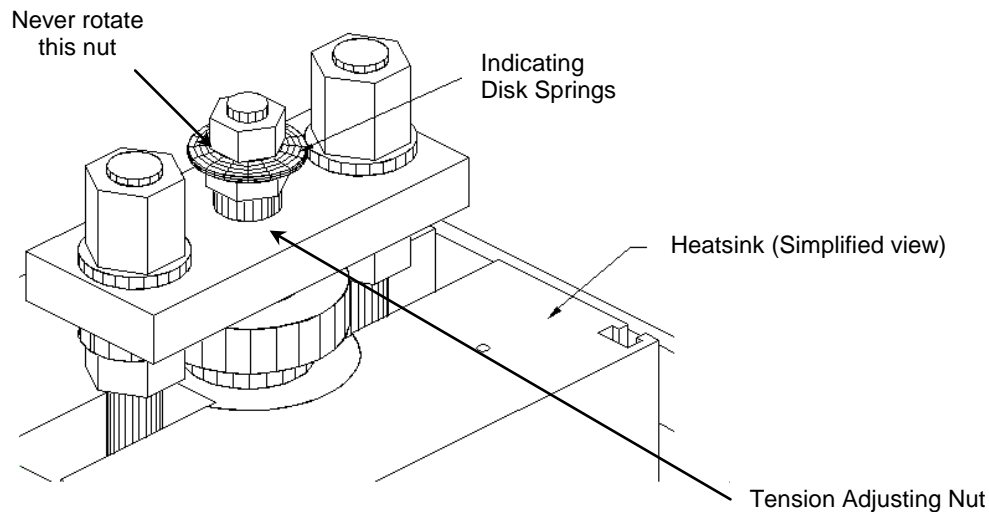


Figure 10.2 – Checking Clamp Force – Machine Side Converter and Line Side Converter Modules

Adjusting Clamp Pressure

If clamp forces have been checked and increasing the clamp force is required, the following procedures should be used.

SNUBBER DIODE

To increase the clamp pressure, torque the M8 bolts in the insulation cups (13-mm wrench). Turn the first bolt 1/4 turn and then torque the other bolt 1/4 turn, check the tabwasher. Repeat this procedure until the tabwasher can just rotate with finger touch.

MACHINE SIDE CONVERTER AND LINE SIDE CONVERTER

To increase the clamp pressure, torque only the adjusting nut below the two indicating disc springs shown in Figure 10.2 (21 mm open end wrench). Turn adjusting nut 1/4 turn, check the indicating disc springs. Repeat until the indicating disc springs can just rotate with finger touch.

Power Semiconductor Replacement

If a device is found to be faulty, you must replace all devices in that leg. The devices are matched for characteristics at the factory, ensuring proper operation. Mixed characteristics may cause premature failure in the drive. This does not apply to diodes.

Replacing Thyristors - Line side converter

NOTE: Before disconnecting any leads from the circuit, note all lead connections for reassembly.

1. Remove Line side converter Heatsink Stack Assembly from Drive

Disconnect the Gate(G), Cathode (C) and Diagnostic (D) leads from the SCR gate driver boards. Disconnect the fiber optic leads, D.C Power leads to the gate driver and power supply boards. Disconnect leads on the thermistor board (if applicable). Remove the circuit board mounting glastic plate using ¼ inch hardware. To access the center phase machine side converter, the door mullion steel channel can be removed for better access.

Before disconnecting any lead, please note all lead connections for re-assembly. After removing the circuit board mounting glastic plate, disconnect the sharing/diagnostic resistors from the heatsink. These resistors are mounted on the left side of the heatsink stack. Disconnect the snubber resistor leads at the heatsink and snubber capacitors. The snubber resistors are mounted on the right side of the heatsink stack assembly.

2. Heatsink Stack Removal

Remove 3/8" nut and bolt, which connect copper bus and the heatsink stack bus link. Disconnect the incoming cables at the heatsink. First remove 3/8" nuts at bottom and then top of heatsink stack-mounting bracket insulator. While taking the top nuts out, make sure that the heatsink stack is handled carefully. Extract heatsink stack completely with snubber capacitors from the drive without touching the snubber and sharing/diagnostic resistors. Lay down the flat surface (left side) of the heatsink stack on a flat surface.



CAUTION: Heatsink Stack is heavy and it is preferred that two people should extract the heatsink stack from the drive. Always check the snubber and sharing/diagnostic resistors after removal of the stack and then follow the next step.

3. Loosen the Heatsink Stack

There are two styles of the heatsinks and each has different procedure to loosen the tension-adjusting nut to get the devices out of the heatsink.

New Style Heatsink stack

Loosen completely the tension-adjusting nut of the clamp head assembly (see Figure 10.2). Open-end wrench is required to rotate the load-adjusting nut. Pry apart the heatsink to take the devices out.



CAUTION: Never rotate the outer nut on the top of the indicating disc. The rotation of the outer nut will effect the torque calibration. Only loosen the tension-adjusting nut. Refer Figures 10.2 and 10.6.

Old Style Heatsink stack

In old style heatsink stack the steel clamping rods are used, see Figure 10.7. Remove the two nuts at the top of the rod shown in Figure 10.7. Replace the silicon if used in the caps of the nuts. After removal of these two nuts the top pressure bar assembly can be removed. Heatsink segment can now be moved so that SCRs can be replaced. Note the orientation of device leads before re-assembly.

4. Replacement of SCRs

Remove the new device from the packing. Don't handle the device by holding its leads. Ensure the face of the new device is free from dirt. Use a clean, lint free cloth to place a thin film of grease (Alcoa EJC No.2) to both side of the device. Replace SCRs with the appropriate matched set noting the orientation of the SCRs. Ensure that locating pins are in place in the heatsinks and that the pins seat properly in the center of each device. Ensure that the orientation of the S.C.R. leads is the same. Tighten the tension adjusting nut (on new style) or two steel clamping rod nuts (on older style), monitor devices ensuring they are centered on the pins of the heatsink. This can be checked, by rotating devices to see if the are centered on the pins.



CAUTION: Never check the rotation of the device by rotating its leads. Check the rotation of the device by rotating the device itself. Don't apply any force on the leads.

5. Reassembly of Heatsink Stack Assembly

- **New Style Heatsink stack**

In new style heatsink, rotate the tension-adjusting nut to reassemble the stack. Tighten the tension-adjustment nut until the indicating disc washer is just able to turn freely with your fingers.

- **Old Style Heatsink stack**

Replace clamp pressure bar assembly on heatsink stack, torque outer M16 clamp nuts finger tight. Before further torquing, ensure that the bottom heatsink mounting bracket's mounting surface extends .50 inch beyond heatsink rear surface (the front channel face of the bracket will align with the front surface of the heatsinks). Also ensure that the glass epoxy rods do not touch any part of the heatsinks (temporary spacers may be required).

When the M16 nuts are torqued in place the distance from the top pressure bar to the bottom pressure bar should be equal from front of the clamp to the back of the clamp to within 0.2mm (.008 in.).

6. Installation of Line side converter Assembly in Drive

NOTE: Before putting the heatsink stack back to the drive, check the new device resistance.



CAUTION: Be very careful, While taking the heatsink stack out or putting in the drive, do not touch the snubber and sharing/diagnostic resistors. Always check the resistors before taking the stack out and after putting the stack back in the drive.

Mount heatsink assembly onto the set of the heatsink stack mounting insulator screws. Reconnect the copper bus with the heatsink bus links. Reconnect snubber and sharing/diagnostic resistor leads back to the heatsink and snubber capacitor, which were disconnected in step 1.

Mount the circuit board assembly loosely on the right hand side only. Guide the S.C.R., diagnostic resistor and thermistor lead (if applicable) through the appropriate wiring clearance holes of the circuit board mounting plate. Reassemble hardware on the left side of the circuit board assembly and torque all mounting hardware for the circuit board mounting assembly. Connect back the fiber optics, 48 volt D.C. supply leads, diagnostic resistor lead, cathode and gate leads, and thermistor (if applicable) lead.

If the vertical door mullion was removed for access, it must be re-installed and door interlock operation must be tested.

7. Calibration and Gate Pulse Verification

Refer to page 10-14 and follow the SCR Gate Driver Calibration and Gate Pulse Verification Procedure.

Replacing Thyristors - Machine side converter

1. Remove Machine side converter Heatsink Stack Assembly from Drive

Disconnect the Gate(G), Cathode (C) and Diagnostic (D) leads from the GTO gate driver boards. Disconnect the fiber optic leads, D.C Power leads to the gate driver and power supply boards. Disconnect leads on the thermistor board (if applicable). Remove the circuit board mounting glastic plate using ¼ in. hardware. To access the center phase machine side converter, the door mullion steel channel can be removed for better access.

Before disconnecting any lead, please note all lead connections for re-assembly. After removing the circuit board mounting glastic plate, disconnect the sharing/diagnostic resistors from the heatsink. These resistors are mounted on the left side of the heatsink stack. Disconnect the snubber resistor leads from the heatsink and snubber capacitors. The snubber resistors are mounted on the right side of the heatsink stack assembly.

2. Heatsink Stack Removal

First remove 3/8" nuts at bottom and then top of heatsink stack-mounting bracket insulator. While taking the top nuts out, make sure that the heatsink stack is handled very carefully because the sharing/diagnostic and snubber resistor are very close to the stack. Little care may cause the damage to these resistors by touching the stack with the resistors while taking the stack out of the drive. Extract heatsink stack completely with snubber capacitor and diode from the drive without touching the snubber and sharing/diagnostic resistors. Lay down the flat surface (left side) of the heatsink stack on a flat surface.



CAUTION: The heatsink stack is heavy. Use two people to remove the heatsink stack from the drive. Failure to do so may result in injury to personnel and/or damage to the equipment.

3. Loosen the Heatsink Stack

Loosen completely the tension-adjusting nut of the clamp head assembly (see Figure 10.2). Open-end wrench is required to rotate the load-adjusting nut. Pry apart the heatsink to take the devices out.



CAUTION: Never rotate the outer nut on the top of the indicating disc. The rotation of the outer nut will effect the torque calibration. Only loosen the tension-adjusting nut. Refer Figure 10.2 and 10.6.

The machine side heatsink stack can be viewed in Figure 10.3.

Exploded View of 2300 Volt Machine Side Converter

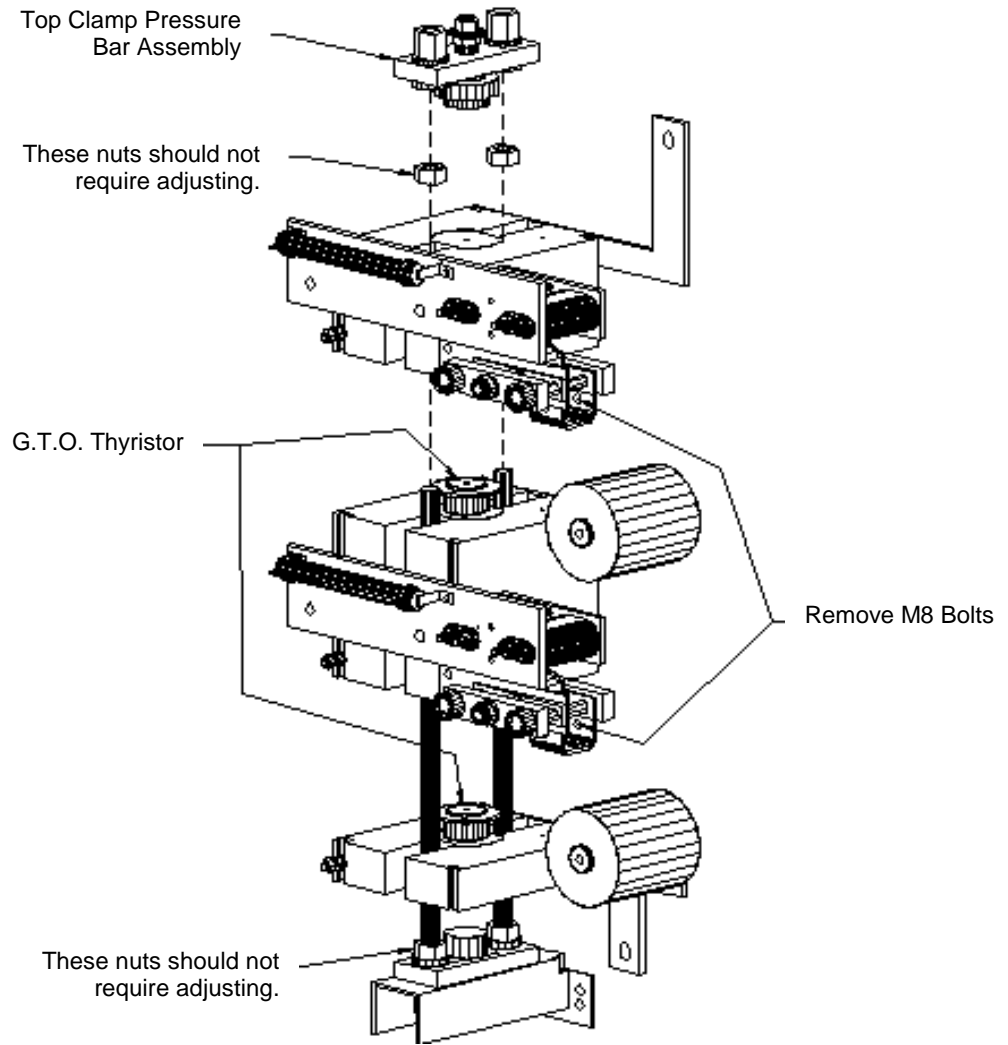


Figure 10.3 – Replacement of Thyristors

4. Replacement of GTOs

Remove the new device from the packing. Don't handle the device by holding its leads. Ensure the face of the new device is free from dirt. Use a clean, lint free cloth to place a thin film of grease (Alcoa EJC No.2) to both side of the device. Replace GTOs with the appropriate matched set noting the orientation of the GTOs. Ensure that locating pins are in place in the heatsinks and that the pins seat properly in the center of each device. Ensure that the orientation of the G.T.O. leads is the same. Tighten the tension- adjusting nut, monitor devices ensuring they are centered on the pins of the heatsink. This can be checked, by rotating devices to see if the are centered on the pins.



CAUTION: Never check the rotation of the device by rotating its leads. Check the rotation of the device by rotating the device itself. Don't apply any force on the leads.

5. Reassembly of Heatsink Stack Assembly

Only the tension-adjusting nut should be rotate to reassemble the stack. Tighten the tension-adjustment nut until the indicating disc washer is just able to turn freely with your fingers.

6. Installation of Machine side converter Assembly in Drive

NOTE: Before putting the heatsink stack back to the drive, check the new device resistance.

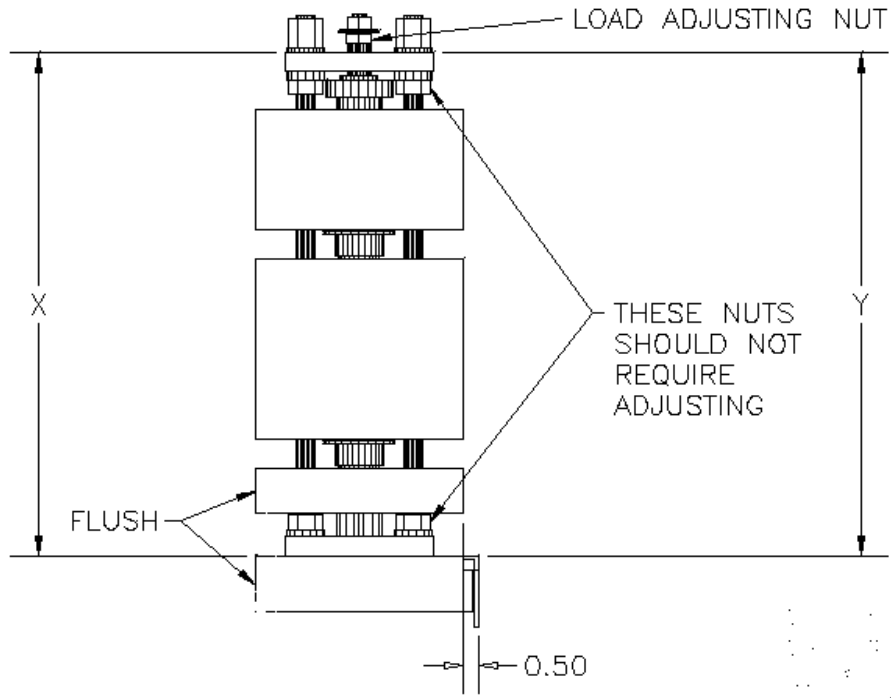


CAUTION: Be very careful, While taking the heatsink stack out or putting in the drive, do not touch the snubber and sharing/diagnostic resistors. Always check the resistors before taking the stack out and after putting the stack back in the drive.

Mount heatsink assembly onto the set of the heatsink stack mounting insulator screws. Reconnect the copper bus with the heatsink bus links. Reconnect snubber and sharing/diagnostic resistor leads back to the heat sink and snubber capacitor, which were disconnected in step 1.

Mount the circuit board assembly loosely on the right hand side only. Guide the G.T.O., diagnostic resistor and thermistor lead (if applicable) through the appropriate wiring clearance holes of the circuit board mounting plate. Reassemble hardware on the left side of the circuit board assembly and torque all mounting hardware for the circuit board mounting assembly. Connect back the fiber optics, 48 volt D.C. supply leads, diagnostic resistor lead, cathode and gate leads, and thermistor (if applicable) lead.

If the vertical steel door mullion was removed for access, it must be re-installed and the operation of the door interlocks must be tested.



DIFFERENCE BETWEEN DIMENSIONS X AND Y TO BE 0.2 mm (.008 in.) MAXIMUM

Figure 10.4 – Positioning of Heatsink Bracket

6. Calibration and Gate Pulse Verification

Depending on the current rating of the GTO refer to the appropriate GTO Gate Driver Calibration and Gate Pulse Verification Procedure found on pages 10-15 to 10-17.

Replacing Snubber Diodes

Snubber diodes can be replaced without having to remove the heatsink assembly from the drive. The circuit board assembly must be removed as described previously in REPLACING THYRISTORS-MACHINE SIDE CONVERTER part 1. Remove 1/4 in. nuts of the heatsink to snubber diode link at the front of the heatsink. Remove the M8 bolts of the diode clamp. The clamp and heatsink to diode link can now be removed (see Figure 10.5).

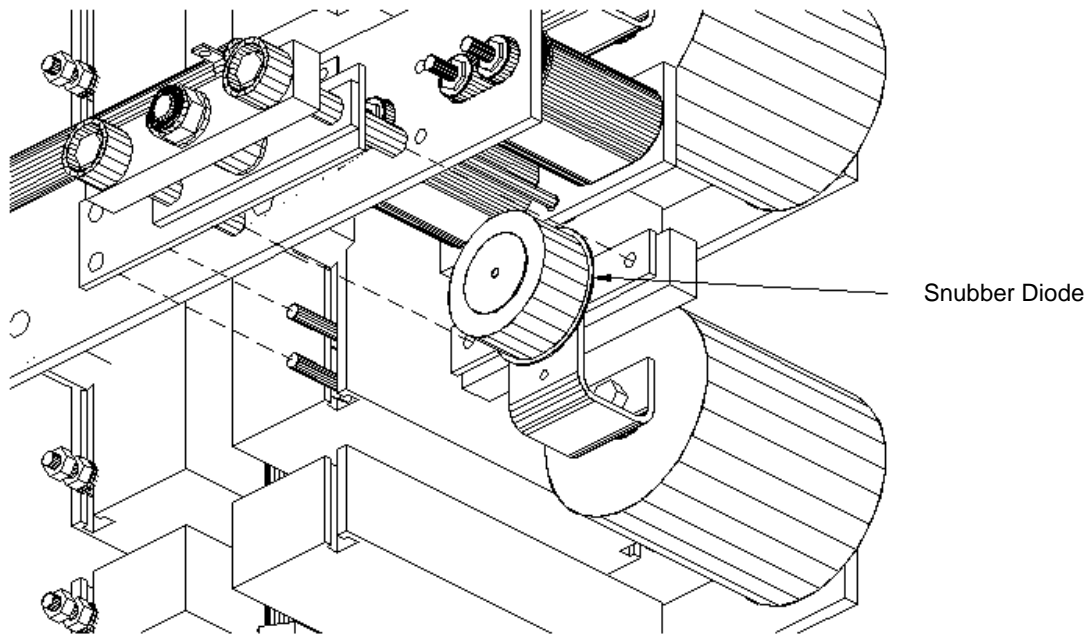


Figure 10.5 – Replacement of Snubber Diode

Replace the snubber diode, noting its orientation and ensuring that there is a thin film of electrical joint. Reassemble clamp and link. Torque the M8 bolts of the clamp evenly until the tabwasher can just be rotated with finger touch.

NOTE: The following Figure shows the line side converter heatsink stack assembly. Some type of machine side converter heatsink stack assembly does not have the bottom nuts on the fiberglass-

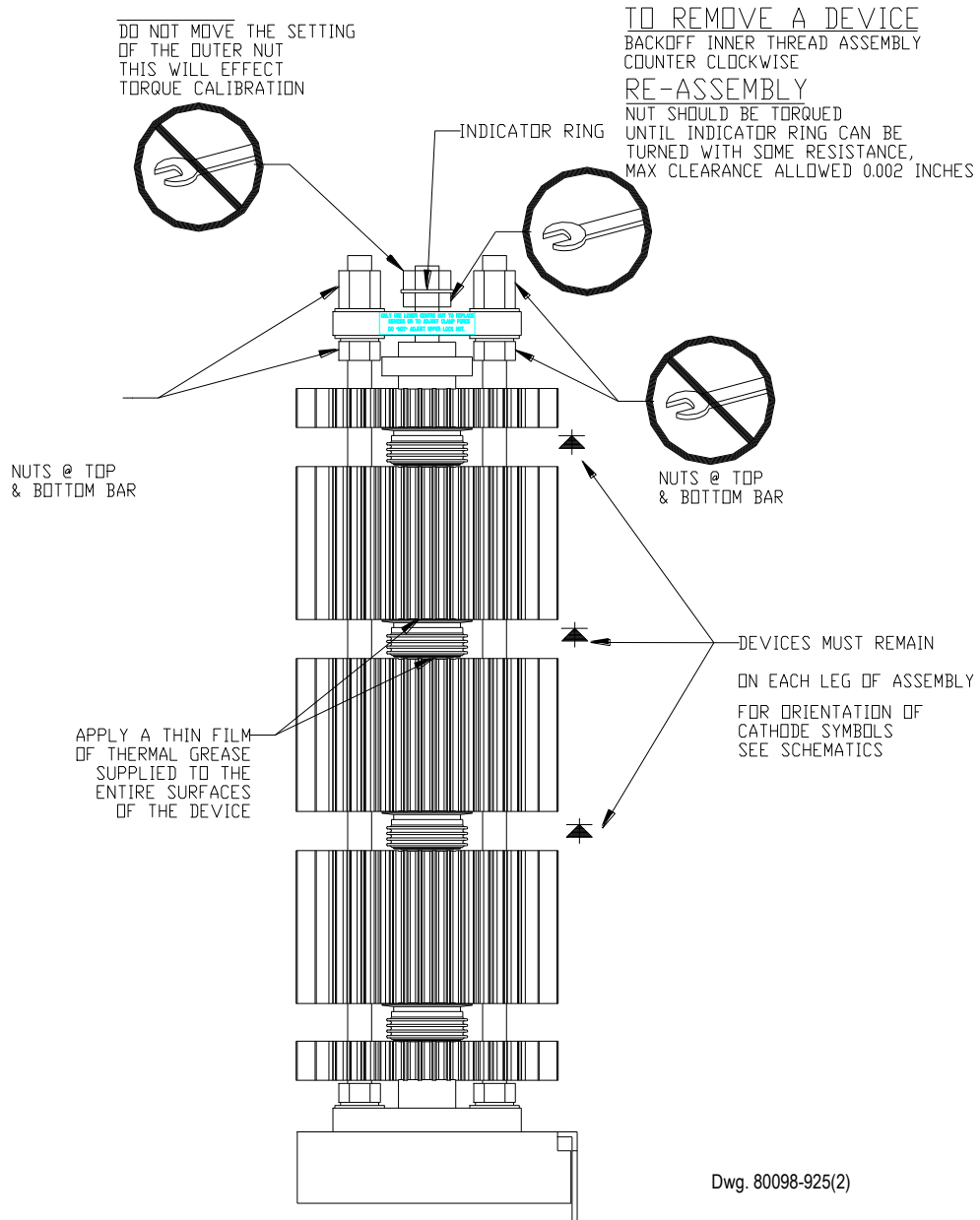


Figure 10.6 – New Style Heatsink Stack Assembly

ALLEN-BRADLEY

GTO & SCR REPLACEMENT INSTRUCTION SHEET

For assemblies with (STEEL CLAMPING RODS)

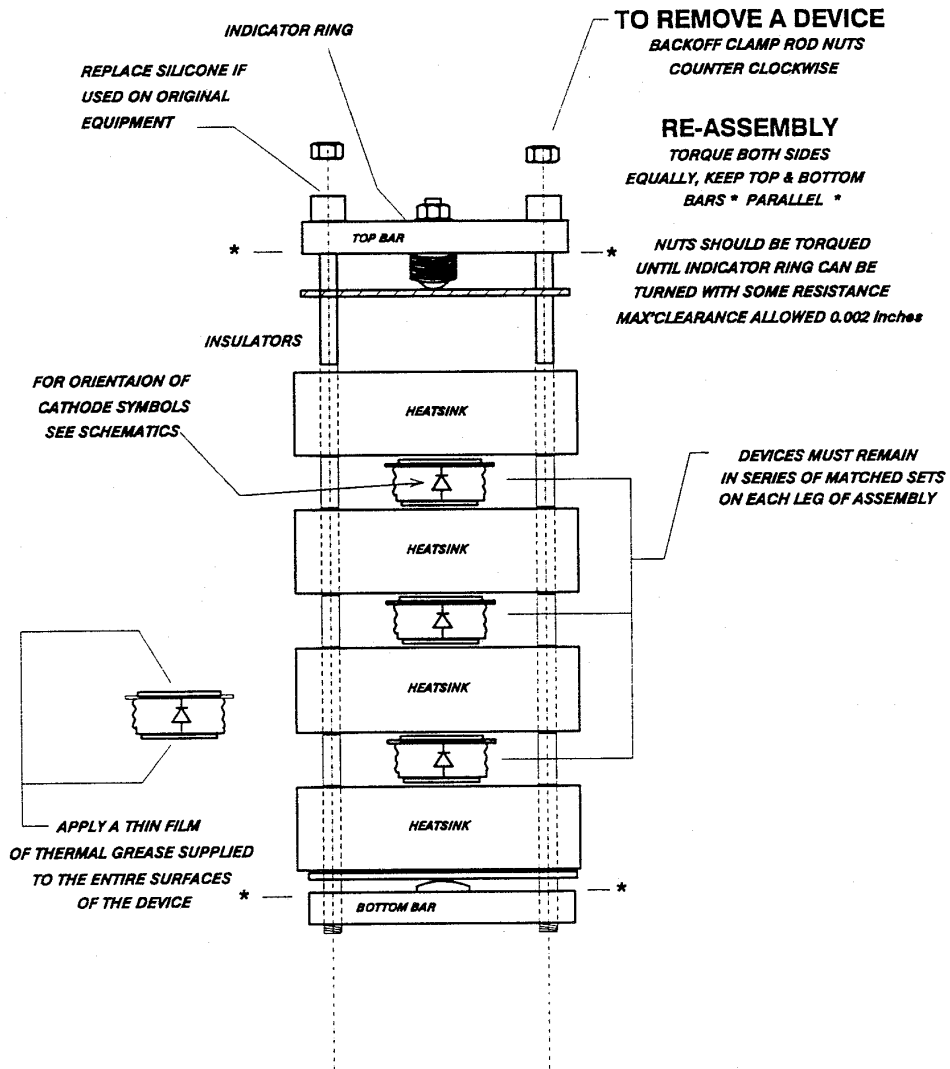


Figure 10.7 – Old Style Heatsink

Replacing Snubber Capacitors

Snubber capacitors in both the machine side converter and line side converter assemblies can be replaced without having to remove the heatsink assemblies from the drive. For 4160 volt drives it may be necessary to remove the small snubber resistor and capacitor assembly so that there is sufficient room to remove the capacitor.

In the machine side converter assembly, remove the M8 bolt at the front of the capacitor. Remove the ¼” nuts which fasten the snubber diode copper link to the heatsink. The snubber diode can now be removed complete with its clamp and links. Rotate the capacitor counter-clockwise by hand so that the capacitor can be removed. Note the M8 hardware at the back of the capacitor is locked in place with adhesive because of its access difficulty.

Install the new capacitor by threading it onto the M8 bolt by hand. Replace all the links described in the removal procedure.

In the line side converter assembly, remove the M8 bolt at the front of the capacitor. Rotate the capacitor counter-clockwise by hand so that the capacitor can be removed. Note the M8 hardware at the back of the capacitor is locked in place with adhesive because of its access difficulty. Install the new capacitor by threading it onto the M8 bolt by hand. Reassemble the front M8 bolt and leads.

Replacing Snubber Resistors

Snubber resistors are mounted on vertical glass polyester channels. The channels should not be removed from the drive because they form part of its internal support structure.

Replacing DI/DT Reactors

Di/Dt reactors (air core chokes) are located behind the insulation barriers of the machine side converter section. They are designed to be removed with front access, however; if rear access is available; it is easier.

In the case of rear access, remove the rear cabinet covers and access is available to the mounting hardware and links of the reactors.

In the case of front access, the machine side converter heatsink assemblies must be removed as described previously in REPLACEMENT OF THYRISTORS – MACHINE SIDE CONVERTER. The snubber resistor assemblies on the right hand side of the machine side converter section must be removed. Remove the mounting hardware of the large barrier at the back of the machine side converter section. After removal of the barrier, mounting hardware of the reactors is now accessible.

Ensure that the polarity marks of the reactor are in the correct position when the new reactor is installed.

Replacing Cooling Fans

There are several models of cooling fans used in 1557 drives. Differing fan types may be used in the various locations of fans throughout the drive.

TOP OF MACHINE SIDE CONVERTER SECTION

Check the model of cooling fans of the by removing the ventilation cover from the outside of the top plate of the cabinet.

To replace Rotron “Caravel” or “Tarzan” fans, remove the barrier located above the machine side converter gate driver board assemblies. Disconnect the fan leads. Remove the fan mounting plate from the exterior of the cabinet. Mounting hardware of the fans is now accessible.

To replace EBM Votron fans, removal of interior barriers is not required. Remove the top plate of the ventilation housing and disconnect the fan leads. Remove the cross channel to which the fan is mounted. Mounting hardware of the fans is now accessible.

BOTTOM OF LINE SIDE CONVERTER SECTION

To replace Rotron “Caravel” or “Tarzan” fans, remove the fan support bracket hardware (6 screws) and disconnect the fan leads. Slide the bracket complete with fan up between the vertical channels and turn the bracket up at the front so that the when the bracket is moved down it clears the vertical channels and can be removed. Mounting hardware of the fans is now accessible.

TOP OF D.C. LINK CABINET

Open the upper door of the D.C. link cabinet so that the motor filter capacitors are visible. Disconnect the fan leads. Remove the top ventilation cover from the exterior of the cabinet. Mounting hardware of the fans is now accessible.

Meggering Procedure

The following procedure is to be used during commissioning or troubleshooting. Meggering the drive allows you to find any ground faults without damaging the drive.

1. Disconnect any incoming power sources, medium voltage sources should be locked off and control power should be turned off at the circuit breaker.
2. Verify with potential indicator that power has been disconnected.
3. Disconnect the following:
 - The J1, J2 Ribbon cables and Gnd. Wires on all Voltage Feedback Boards (VFB).
 - The Gnd. Wire connection at the Output Ground Network.
4. Connect the megger between cabinet ground and one of the drive input or drive output terminals and megger the drive with a DC voltage equivalent to its AC rating. The reading should be 5,000 Meg Ohms at least, preferred is 10,000 Meg Ohms plus for one minute. The reading will vary depending upon the size and number of output capacitors. If in doubt isolate the output capacitors
5. Discharge the system to ground.
6. Reconnect the ribbon cables and gnd wires that were previously disconnected.

If you obtain values below the recommended, contact Medium Voltage Product Support.

Drive Faults

Fault Code #	FAULT MESSAGE	F	Description
F0	Line selftst	F	The line converter control board has failed its power up self-test. This fault can only be cleared by turning off the control power.
F1	Line param	F	The parameters stored in EEPROM on the Line Converter control board have been corrupted.
F2	Line s/w w/d	F	Line side software watchdog has expired.
F3	Line h/w w/d	F	Line side hardware watchdog timer has expired
F4	Line s/w o/c	F	The line current feedback has exceeded the level in P161 for the duration in P162.
F5	Line h/w o/c	F	The instantaneous line current has exceeded the level in P169 for the duration in P170.
F6	Line ac o/v	F	The line voltage has exceeded the level in P165 for the duration in P166
F7	Line dc o/v	F	The line side dc link voltage has exceeded the level in P187 for the duration in P188.
F8	12p phasing or Line phasing	F	This fault indicated on 12 or 18 pulse drives only. Either the phase rotation of the line voltage is reversed or the phase angle relationships between the slave bridge(s) and the master bridge is incorrect. Firmware revision numbers less than 5.00 termed "12 p phasing" Firmware revision numbers greater than 5.00 termed "Line phasing"
F9	Ground fault	F	The signal from the ground fault CT has exceeded the level in P171 for the duration in P172.
F10	Line thy open	F	An open thyristor has been detected in the line converter.
F11	Line thy short	F	A shorted thyristor has been detected in the line converter.
F12	Ac cntrl pwr	F	The 48Vdc-power supply has reported an AC voltage fault. Check control power supply.
F13	Ln unbalance	F	The unbalance in the line voltage or current feedback is greater than 0.1 pu for more than 100 cycles. If the drive is running it is a current balance fault, and if the drive is not running it is a voltage balance fault.
F14	Input open	F	The input contactor has opened when the drive was running.
F15	Pulse number	F	Parameter Pulse Number (P153) has been changed and the drive control power was not cycled.
F16	Mtr selftst	F	The machine converter control board has failed its power up self-test. This fault can be cleared only by turning off the control power.
F17	Mtr parm	F	The parameters stored in EEPROM on the Machine Converter Control Board have been corrupted.
F18	Mtr s/w w/d	F	Motor side software watchdog timer has expired.
F19	Mtr h/w w/d	F	Motor side hardware watchdog timer has expired.
F20	Mtr s/w o/c	F	The motor current has exceeded the level in P177 for the duration in P178.
F21	Mtr h/w o/c	F	The motor current has exceeded the level in P177 for the duration in P178.
F22	Mtr ac o/v	F	The motor voltage has exceeded the level in P181 for the duration in P182.
F23	Mtr dc o/v	F	The motor side DC link voltage has exceeded P187 for the duration in P188.

Drive Faults

Fault Code #	FAULT MESSAGE	F	Description
F24	Mtr stall	F	The drive has detected a motor stall condition.
F25	dc\dc fail	F	The dc\dc converter has reported a failure in one or more of the non-redundant outputs or both outputs of the redundant supplies have failed. The threshold for fail condition is 95% of rated output voltage.
F26	Mtr thy open	F	An open GTO has been detected in the machine converter. A GTO failure is detected before starting or when the motor voltage exceeds 0.25 pu, after starting.
F27	Mtr thy short	F	A shorted GTO has been detected in the machine converter. A GTO failure is detected before starting or when the motor voltage exceeds 0.25pu, after starting.
F28	DC cntrl pwr	F	The 48Vdc-power supply has reported a DC voltage fault. Check control power supply.
F29	Mtr unbalance	F	The unbalance in the motor current feedback has exceeded the level in P183 for the duration in P184, or the unbalance in the motor flux feedback has exceeded 0.1 pu for 100 cycles.
F30	Output open	F	The output contactor has opened when the drive was running.
F31	No Vdc fdbk	F	No machine side dc link voltage feedback detected during the GTO gating test when the drive is started. Usually indicates that the dc voltage feedback is not connected
F32	Drv overload	F	The drive overload rating in P163 has been exceeded for the duration in P164.
F33	Mtr overload	F	The motor overload rating in P179 has been exceeded for the duration in P180.
F34	Mtr over spd	F	The motor speed feedback has exceeded P185 for the duration in P186
F35	Control temp	F	Temperature on the drive control board is above 70 degrees centigrade. Firmware revision numbers less than 5.00 this warning not implemented
F36	Syncxfer fail	F	A synchronous transfer was not completed within the time specified by P230. The drive will stop.
F37	Neutral o/v	F	The motor Neutral to Ground voltage has exceeded the level in P189 for the duration in P190.
F38	SCANport flt	F	This fault indicates that one of the four non-maskable Scan ports warning have occurred. <ol style="list-style-type: none"> 1. Communication Processor board failure (comm proc brd) 2. Loss of adapter (Adapter loss) 3. Speed command loss (spdcmd loss) 4. Loss of local control (Local loss)
F39	Fan Loss	F	The output of the static pressure sensor fell below 80% of the level in P175 for the duration in P176.
F40	Over temp 1	F	Heatsink over temperature is present, 85 degrees centigrade exceeded.
F41	Over temp 2	F	Heatsink over temperature is present, 85 degrees centigrade exceeded.
F42	Over temp 3	F	Heatsink over temperature is present, 85 degrees centigrade exceeded.
F43	Under temp	F	Heatsink temperature is below # 40 degrees centigrade.

Drive Faults

Fault Code #	FAULT MESSAGE	F	Description
F44	Over temp 5	F	Heatsink over temperature is present, 85 degrees centigrade exceeded.
F45	Over temp 6	F	Heatsink over temperature is present, 85 degrees centigrade exceeded.
F46	Over temp 7	F	Heatsink over temperature is present, 85 degrees centigrade exceeded.
F47	Firmware rev	F	Firmware in the two drive control boards or the communication processor board is not compatible.
F256	Drv o/l warn	W	The drive overload protection has reached 50% of the trip value in P163.
F257	Mtr o/l warn	W	The motor overload level has reached 50% of the trip value in P179.
F258	Line u/v	W	The line voltage has fallen below the level in P167 for the duration in P168.
F259	Line rev seq	W	The drive attempted to make a synchronous transfer with reverse sequence line voltage. Sync transfer cancelled.
F260	Input open	W	The input contactor is open when it is requested to be closed
F261	Input closed	W	The input contactor is closed when it is requested to be open
F262	Output open	W	The output contactor is open when it is requested to be closed.
F263	Output closed	W	The output contactor is closed when it is requested to be opened.
F264	Bypass open	W	The bypass contactor is open when it is requested to be closed.
F265	Bypass closed	W	The bypass contactor is closed when it is requested to be open.
F266	Tach loss	W	The tach signal has been lost to the tach feedback board.
F267	H/w o/c warn	W	Hardware overcurrent warning. The DC O/C trip level (P169) has been exceeded. A GTO gate freeze will be initiated.
F268	H/w o/v warn	W	Hardware overvoltage warning. The DC O/V trip level (P187) has been exceeded. A GTO gate freeze will be initiated.
F269	Tach rotn	W	Phase A and B of the tachometer is interchanged.
F270	Line sync	W	The line converter gating has lost synchronization with the line voltage. The drive will shut off momentarily and restart.
F271	dc\dc warn	W	The dc\dc converter has reported a failure in one of the redundant outputs. The threshold for fail condition is 95% of rated output voltage.
F272	Rated rpm	W	Rated motor rpm parameter P26 has been set to an invalid value.
F273	PWM too high	W	The PWM frequency parameter P155 has been set too high for the drive ratings. It will be changed to a lower value.
F274	Rated I fbk	W	The current feedback scaling is out of range.
F275	Filter cap	W	The per unit filter capacitor is out of range. Value must fall within the range 0.25 per unit to 0.75 per unit.
F276	Not used		
F277	Not used		
F278	Not used		
F279	Not used		
F280	Not used		
F281	Fan Loss	W	The output of the static pressure sensor fell below the level in P175 for the duration in P176.

Drive Faults

Fault Code #	FAULT MESSAGE	F	Description
F282	Syncxfer fail	W	A synchronous transfer was not completed within the time specified by parameter Sync xfer time (P230). The drive will continue to run.
F283	Not used	W	
F284	Com proc brd	W	Indicates that the communication board is not communicating with drive control board or the board has failed self-power test, which requires recycling of the power.
F285	Adapter loss	W	The drive has lost communication with a SCANport adapter.
F286	Spd cmd loss	W	The drive has lost communication with the SCANport adapter providing the speed command.
F287	Local loss	W	
F288	Tuning abort	W	Autotuning was unable to complete the measurement of the tuning parameter within allowed time.
F289	In test mode	W	Indicated that the drive is set in a test mode
F290	Reg in limit	W	Speed regulator or flux regulator hit the limit during auto tuning and the auto tune results are not valid.
F291	R stator hi	W	Indicated the motor cables are extremely long.
F292	Time limit	W	Indicates the autotuning could not measure the parameter within allowed time limit.
F293	Inertia high	W	Indicates that the measured inertia is greater than 5.0 sec.
F294	L comm low	W	Indicates the measured commutation inductance is less than 0.02 pu. Require manual tuning of commutation inductance.
F295	L comm high	W	Indicates the measured commutation inductance is greater than 0.15pu. Require manual tuning of the commutation inductance.
F296	T dc low	W	Indicates the measured DC link time constant is less than 0.020 sec. Require manual tuning of DC link time constant.
F297	T dc high	W	Indicates the measured DC link time constant is greater than 0.100sec. Require manual tuning of DC link time constant.
F298	L leakage lo	W	Indicates the measured leakage inductance is less than 0.15pu.
F299	L leakage hi	W	Indicates the measured leakage inductance is greater than 0.30pu.
F300	L magn low	W	Indicates the measured magnetising inductance is less than 2.0pu. Require manual tuning for flux regulator.
F301	L magn hi	W	Indicates the measured magnetising inductance is greater than 10.0pu. Require manual tuning for flux regulator.
F302	T rotor low	W	Indicates the measured rotor time constant is less than 0.2sec. It requires manual tuning of rotor time constant.
F303	T rotor high	W	Indicates the measured rotor time constant is greater than 5.0sec. It requires manual tuning of rotor time constant.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F304	L1A open	Thyristor 1A in Line Converter is open.
F305	L1C open	Thyristor 1C in Line Converter is open.
F306	L1B open	Thyristor 1B in Line Converter is open.
F307	L1D open	Thyristor 1D in Line Converter is open.
F308	L1E open	Thyristor 1E in Line Converter is open.
F309	L1F open	Thyristor 1F in Line Converter is open.
F310	L1G open	Thyristor 1G in Line Converter is open.
F311	L1H open	Thyristor 1H in Line Converter is open.
F312	L1A shorted	Thyristor 1A in Line Converter is shorted.
F313	L1C shorted	Thyristor 1C in Line Converter is shorted.
F314	L1B shorted	Thyristor 1B in Line Converter is shorted.
F315	L1D shorted	Thyristor 1D in Line Converter is shorted.
F316	L1E shorted	Thyristor 1E in Line Converter is shorted.
F317	L1F shorted	Thyristor 1F in Line Converter is shorted.
F318	L1G shorted	Thyristor 1G in Line Converter is shorted.
F319	L1H shorted	Thyristor 1H in Line Converter is shorted.
F320	L2A open	Thyristor 2A in Line Converter is open.
F321	L2C open	Thyristor 2C in Line Converter is open.
F322	L2B open	Thyristor 2B in Line Converter is open.
F323	L2D open	Thyristor 2D in Line Converter is open.
F324	L2E open	Thyristor 2E in Line Converter is open.
F325	L2F open	Thyristor 2F in Line Converter is open.
F326	L2G open	Thyristor 2G in Line Converter is open.
F327	L2H open	Thyristor 2H in Line Converter is open.
F328	L2A shorted	Thyristor 2A in Line Converter is shorted.
F329	L2C shorted	Thyristor 2C in Line Converter is shorted.
F330	L2B shorted	Thyristor 2B in Line Converter is shorted.
F331	L2D shorted	Thyristor 2D in Line Converter is shorted.
F332	L2E shorted	Thyristor 2E in Line Converter is shorted.
F333	L2F shorted	Thyristor 2F in Line Converter is shorted.
F334	L2G shorted	Thyristor 2G in Line Converter is shorted.
F335	L2H shorted	Thyristor 2H in Line Converter is shorted.
F336	L3A open	Thyristor 3A in Line Converter is open.
F337	L3C open	Thyristor 3C in Line Converter is open.
F338	L3B open	Thyristor 3B in Line Converter is open.
F339	L3D open	Thyristor 3D in Line Converter is open.
F340	L3E open	Thyristor 3E in Line Converter is open.
F341	L3F open	Thyristor 3F in Line Converter is open.
F342	L3G open	Thyristor 3G in Line Converter is open.
F343	L3H open	Thyristor 3H in Line Converter is open.
F344	L3A shorted	Thyristor 3A in Line Converter is shorted.
F345	L3C shorted	Thyristor 3C in Line Converter is shorted.
F346	L3B shorted	Thyristor 3B in Line Converter is shorted.
F347	L3D shorted	Thyristor 3D in Line Converter is shorted.
F348	L3E shorted	Thyristor 3E in Line Converter is shorted.
F349	L3F shorted	Thyristor 3F in Line Converter is shorted.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F350	L3G shorted	Thyristor 3G in Line Converter is shorted.
F351	L3H shorted	Thyristor 3H in Line Converter is shorted.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F352	L4A open	Thyristor 4A in Line Converter is open.
F353	L4C open	Thyristor 4C in Line Converter is open.
F354	L4B open	Thyristor 4B in Line Converter is open.
F355	L4D open	Thyristor 4D in Line Converter is open.
F356	L4E open	Thyristor 4E in Line Converter is open.
F357	L4F open	Thyristor 4F in Line Converter is open.
F358	L4G open	Thyristor 4G in Line Converter is open.
F359	L4H open	Thyristor 4H in Line Converter is open.
F360	L4A shorted	Thyristor 4A in Line Converter is shorted.
F361	L4C shorted	Thyristor 4C in Line Converter is shorted.
F362	L4B shorted	Thyristor 4B in Line Converter is shorted.
F363	L4D shorted	Thyristor 4D in Line Converter is shorted.
F364	L4E shorted	Thyristor 4E in Line Converter is shorted.
F365	L4F shorted	Thyristor 4F in Line Converter is shorted.
F366	L4G shorted	Thyristor 4G in Line Converter is shorted.
F367	L4H shorted	Thyristor 4H in Line Converter is shorted.
F368	L5A open	Thyristor 5A in Line Converter is open.
F369	L5C open	Thyristor 5C in Line Converter is open.
F370	L5B open	Thyristor 5B in Line Converter is open.
F371	L5D open	Thyristor 5D in Line Converter is open.
F372	L5E open	Thyristor 5E in Line Converter is open.
F373	L5F open	Thyristor 5F in Line Converter is open.
F374	L5G open	Thyristor 5G in Line Converter is open.
F375	L5H open	Thyristor 5H in Line Converter is open.
F376	L5A shorted	Thyristor 5A in Line Converter is shorted.
F377	L5C shorted	Thyristor 5C in Line Converter is shorted.
F378	L5B shorted	Thyristor 5B in Line Converter is shorted.
F379	L5D shorted	Thyristor 5D in Line Converter is shorted.
F380	L5E shorted	Thyristor 5E in Line Converter is shorted.
F381	L5F shorted	Thyristor 5F in Line Converter is shorted.
F382	L5G shorted	Thyristor 5G in Line Converter is shorted.
F383	L5H shorted	Thyristor 5H in Line Converter is shorted.
F384	L6A open	Thyristor 6A in Line Converter is open.
F385	L6C open	Thyristor 6C in Line Converter is open.
F386	L6B open	Thyristor 6B in Line Converter is open.
F387	L6D open	Thyristor 6D in Line Converter is open.
F388	L6E open	Thyristor 6E in Line Converter is open.
F389	L6F open	Thyristor 6F in Line Converter is open.
F390	L6G open	Thyristor 6G in Line Converter is open.
F391	L6H open	Thyristor 6H in Line Converter is open.
F392	L6A shorted	Thyristor 6A in Line Converter is shorted.

F393	L6C shorted		Thyristor 6C in Line Converter is shorted.
F394	L6B shorted		Thyristor 6B in Line Converter is shorted.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F395	L6D shorted	Thyristor 6D in Line Converter is shorted.
F396	L6E shorted	Thyristor 6E in Line Converter is shorted.
F397	L6F shorted	Thyristor 6F in Line Converter is shorted.
F398	L6G shorted	Thyristor 6G in Line Converter is shorted.
F399	L6H shorted	Thyristor 6H in Line Converter is shorted.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F400	M1A open	Thyristor 1A in Machine Converter is open.
F401	M1C open	Thyristor 1C in Machine Converter is open.
F402	M1B open	Thyristor 1B in Machine Converter is open.
F403	M1D open	Thyristor 1D in Machine Converter is open.
F404	M1E open	Thyristor 1E in Machine Converter is open.
F405	M1F open	Thyristor 1F in Machine Converter is open.
F406	M1G open	Thyristor 1G in Machine Converter is open.
F407	M1H open	Thyristor 1H in Machine Converter is open.
F408	M1A shorted	Thyristor 1A in Machine Converter is shorted.
F409	M1C shorted	Thyristor 1C in Machine Converter is shorted.
F410	M1B shorted	Thyristor 1B in Machine Converter is shorted.
F411	M1D shorted	Thyristor 1D in Machine Converter is shorted.
F412	M1E shorted	Thyristor 1E in Machine Converter is shorted.
F413	M1F shorted	Thyristor 1F in Machine Converter is shorted.
F414	M1G shorted	Thyristor 1G in Machine Converter is shorted.
F415	M1H shorted	Thyristor 1H in Machine Converter is shorted.
F416	M2A open	Thyristor 2A in Machine Converter is open.
F417	M2C open	Thyristor 2C in Machine Converter is open.
F418	M2B open	Thyristor 2B in Machine Converter is open.
F419	M2D open	Thyristor 2D in Machine Converter is open.
F420	M2E open	Thyristor 2E in Machine Converter is open.
F421	M2F open	Thyristor 2F in Machine Converter is open.
F422	M2G open	Thyristor 2G in Machine Converter is open.
F423	M2H open	Thyristor 2H in Machine Converter is open.
F424	M2A shorted	Thyristor 2A in Machine Converter is shorted.
F425	M2C shorted	Thyristor 2C in Machine Converter is shorted.
F426	M2B shorted	Thyristor 2B in Machine Converter is shorted.
F427	M2D shorted	Thyristor 2D in Machine Converter is shorted.
F428	M2E shorted	Thyristor 2E in Machine Converter is shorted.
F429	M2F shorted	Thyristor 2F in Machine Converter is shorted.
F430	M2G shorted	Thyristor 2G in Machine Converter is shorted.
F431	M2H shorted	Thyristor 2H in Machine Converter is shorted.
F432	M3A open	Thyristor 3A in Machine Converter is open.
F433	M3C open	Thyristor 3C in Machine Converter is open.
F434	M3B open	Thyristor 3B in Machine Converter is open.
F435	M3D open	Thyristor 3D in Machine Converter is open.
F436	M3E open	Thyristor 3E in Machine Converter is open.
F437	M3F open	Thyristor 3F in Machine Converter is open.
F438	M3G open	Thyristor 3G in Machine Converter is open.

F439	M3H open		Thyristor 3H in Machine Converter is open.
F440	M3A shorted		Thyristor 3A in Machine Converter is shorted.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F441	M3C shorted	Thyristor 3C in Machine Converter is shorted.
F442	M3B shorted	Thyristor 3B in Machine Converter is shorted.
F443	M3D shorted	Thyristor 3D in Machine Converter is shorted.
F444	M3E shorted	Thyristor 3E in Machine Converter is shorted.
F445	M3F shorted	Thyristor 3F in Machine Converter is shorted.
F446	M3G shorted	Thyristor 3G in Machine Converter is shorted.
F447	M3H shorted	Thyristor 3H in Machine Converter is shorted.

Drive Faults

Fault Code #	WARNING MESSAGE	Description
F448	M4A open	Thyristor 4A in Machine Converter is open.
F449	M4C open	Thyristor 4C in Machine Converter is open.
F450	M4B open	Thyristor 4B in Machine Converter is open.
F451	M4D open	Thyristor 4D in Machine Converter is open.
F452	M4E open	Thyristor 4E in Machine Converter is open.
F453	M4F open	Thyristor 4F in Machine Converter is open.
F454	M4G open	Thyristor 4G in Machine Converter is open.
F455	M4H open	Thyristor 4H in Machine Converter is open.
F456	M4A shorted	Thyristor 4A in Machine Converter is shorted.
F457	M4C shorted	Thyristor 4C in Machine Converter is shorted.
F458	M4B shorted	Thyristor 4B in Machine Converter is shorted.
F459	M4D shorted	Thyristor 4D in Machine Converter is shorted.
F460	M4E shorted	Thyristor 4E in Machine Converter is shorted.
F461	M4F shorted	Thyristor 4F in Machine Converter is shorted.
F462	M4G shorted	Thyristor 4G in Machine Converter is shorted.
F463	M4H shorted	Thyristor 4H in Machine Converter is shorted.
F464	M5A open	Thyristor 5A in Machine Converter is open.
F465	M5C open	Thyristor 5C in Machine Converter is open.
F466	M5B open	Thyristor 5B in Machine Converter is open.
F467	M5D open	Thyristor 5D in Machine Converter is open.
F468	M5E open	Thyristor 5E in Machine Converter is open.
F469	M5F open	Thyristor 5F in Machine Converter is open.
F470	M5G open	Thyristor 5G in Machine Converter is open.
F471	M5H open	Thyristor 5H in Machine Converter is open.
F472	M5A shorted	Thyristor 5A in Machine Converter is shorted.
F473	M5C shorted	Thyristor 5C in Machine Converter is shorted.
F474	M5B shorted	Thyristor 5B in Machine Converter is shorted.
F475	M5D shorted	Thyristor 5D in Machine Converter is shorted.
F476	M5E shorted	Thyristor 5E in Machine Converter is shorted.
F477	M5F shorted	Thyristor 5F in Machine Converter is shorted.
F478	M5G shorted	Thyristor 5G in Machine Converter is shorted.
F479	M5H shorted	Thyristor 5H in Machine Converter is shorted.
F480	M6A open	Thyristor 6A in Machine Converter is open.
F481	M6C open	Thyristor 6C in Machine Converter is open.
F482	M6B open	Thyristor 6B in Machine Converter is open.
F483	M6D open	Thyristor 6D in Machine Converter is open.
F484	M6E open	Thyristor 6E in Machine Converter is open.

F485	M6F open		Thyristor 6F in Machine Converter is open.
F486	M6G open		Thyristor 6G in Machine Converter is open.

Drive Faults

Fault Code #	WARNING MESSAGE		Description
F487	M6H open		Thyristor 6H in Machine Converter is open.
F488	M6A shorted		Thyristor 6A in Machine Converter is shorted.
F489	M6C shorted		Thyristor 6C in Machine Converter is shorted.
F490	M6B shorted		Thyristor 6B in Machine Converter is shorted.
F491	M6D shorted		Thyristor 6D in Machine Converter is shorted.
F492	M6E shorted		Thyristor 6E in Machine Converter is shorted.
F493	M6F shorted		Thyristor 6F in Machine Converter is shorted.
F494	M6G shorted		Thyristor 6G in Machine Converter is shorted.
F495	M6H shorted		Thyristor 6H in Machine Converter is shorted.

Drive Faults

Fault Code #	FAULT MESSAGE	C L A S S	Description
F512	Ext 1	*	User defined external fault.
F513	Ext 2	*	User defined external fault.
F514	Ext 3	*	User defined external fault.
F515	Ext 4	*	User defined external fault.
F516	Ext 5	*	User defined external fault.
F517	Ext 6	*	User defined external fault.
F518	Ext 7	*	User defined external fault.
F519	Ext 8	*	User defined external fault.
F520	Ext 9	*	User defined external fault.
F521	Ext 10	*	User defined external fault.
F522	Ext 11	*	User defined external fault.
F523	Ext 12	*	User defined external fault.
F524	Ext 13	*	User defined external fault.
F525	Ext 14	*	User defined external fault.
F526	Ext 15	*	User defined external fault.
F527	Ext 16	*	User defined external fault.

* Class of fault is assignable

NOTE:

The text description for the external fault messages can only be entered via the PanelView 550 terminal. The HIM module does not have the capability to allow the entering of the text messages.

Troubleshooting Guide

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
1	LINE CONTACTOR WILL NOT CLOSE IN TEST MODE #3	1. MAINTAINED E. STOP DEPRESSED 2. EXTERNAL EMERGENCY STOP PB OR CUSTOMER'S PERMISSIVE CONTACTS NOT CLOSED (IF PROVIDED) 3. RELAYS CR1 & CR2 NOT ENERGIZED 4. THE AUXILIARY CONTACTS OF CR2 DO NOT MAKE 5. CR & CR2 ENERGIZED BUT MAIN CONTACTOR DOES NOT CLOSE	1A. RESET DRIVE E. STOP 2A. CHECK THE E-STOP CONTACT FROM CUSTOMERS T-B TO DRIVE T-B 3A. CHECK FOR THE AVAILABILITY OF CONTROL POWER B. CHECK WHETHER START PB IS O.K. C. CHECK FOR DRIVE PERMISSIVE FROM CUSTOMERS PLC (IF ANY) D. CHECK THE POSITION OF NORMAL/OFF-TEST SELECTOR SWITCH E. CHECK THE INTEGRITY OF THE LINE SIDE CONVERTER IN THE L.V. PANEL F. CHECK THE COILS OF CR. & CR2 CONTACTORS 4A. CHECK THE AUXILIARY CONTACT (DELAYED OPENING NC CONTACT) OF MAIN CONTACTOR IN CR2 CONTROL CIRCUIT B. CHECK THE CONTACTS & REPLACE THE CONTACTOR 5A. CHECK THE "HC" & "CC" OF THE MAIN CONTACTOR
2	INPUT CONTACTOR WILL NOT HOLD IN	1. HOLDING COIL IS NOT ENERGIZED	1A. CHECK THAT THE CONTROL WIRE PLUG IS INSERTED PROPERLY B. CHECK THE INTEGRITY OF THE HOLDING COIL C. CHECK FOR THE PRESENCE OF METAL PARTICLES ON THE ARMATURE D. CHECK THE GAP ON THE "M" MAIN CONTACTOR AUXILIARY ASSEMBLY
3	DRIVE DOES NOT RESPOND TO START COMMAND	1. NO CONTROL POWER 2. MEDIUM VOLTAGE NOT PRESENT 3. FAULT ON DRIVE	1A. CHECK FOR THE AVAILABILITY OF CONTROL POWER FROM CUSTOMER (IF APPLICABLE) B. CHECK THE MAIN ISOLATOR (IF POWER IS FROM CPT) AND CLOSE IF NECESSARY C. CHECK THE CONTROL FUSES D. CHECK THE INTEGRITY OF AUXILIARY CONTACTS OF ISOLATOR E. CHECK THE POSITION OF TEST/ OFF/ NORMAL SELECTOR SWITCH & TURN THE POSITION TO NORMAL 2A. CHECK WHETHER MV IS AVAILABLE FROM CUSTOMER'S SIDE B. CHECK THAT INPUT ISOLATOR IS CLOSED C. CHECK THE TRANSIENT SUPPRESSION NETWORK FUSES. D. CHECK THE MAIN FUSES 3A. CHECK THE PANELVIEW OR HIM MODULE FOR ALARMS. DETERMINE THE REASONS AND RESET

Continue...

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
3	DRIVE DOES NOT RESPOND TO START COMMAND (CONT'D)	4. LOCAL/REMOTE SWITCH IN WRONG POSITION 5. NORMAL/OFF/TEST SELECTOR IN OFF POSITION 6. NO DC POWER 7. GREEN LED OFF ON DRIVE CONTROL BOARD 8. LEDs ON DRIVE I/O BOARD ARE OFF 9. NO COMMAND FROM CUSTOMER'S PLC 10. REMOTE I/O COMMUNICATION MODULE INDICATING ERROR 11. NO POWER SUPPLY TO TACHOMETER (IF EQUIPPED) 12. DEFECTIVE MOTOR OUTPUT CAPACITORS	4A. POSITION OF THE SWITCH TO PROPER POSITION B. CHECK THE INTEGRITY OF CONTACTS C. CHECK THE REMOTE I/O BOARD FOR PROPER LED TO BE ON 5A. SWITCH TO NORMAL POSITION 6A. CHECK FOR THE PRESENCE OF AC CONTROL VOLTAGE B. CHECK FOR DC VOLTAGE FROM DC/DC CONVERTER 7A. CHECK FOR THE +5V, +15v, -15V AT DOB's B. REPLACE THE FIRMWARE CHIPS C. CHECK THAT THE RIBBON CABLES ARE IN POSITION D. REPLACE THE DCBs 8A. CHECK THE RIBBON CABLE FROM LINE DCB TO I/O BOARD B. CHECK FOR CONTROL POWER AT I/O BOARD 9A. CHECK WHY CUSTOMER SIDE PLC RUN COMMAND IS NOT PRESENT B. IF A REMOTE I/O COMMUNICATION MODULE (1203) IS USED, CHECK THE DIP SWITCHES FOR PROPER CONFIGURATION 10A. CHECK THAT THE C.P.B. IS FUNCTIONAL (GREEN LED ON) B. CHECK THE RIBBON CABLES FROM C.P.B. TO BUL 1203 GD1 C. CHECK THE POWER SUPPLY AT 1203 GDI D. CHECK WHETHER CUSTOMER'S CABLES ARE TERMINATED AT 1203 GD1 11A. CHECK THE POWER SUPPLY TO TACHOMETER B. CHECK THE CABLING TO TACHOMETER C. CHECK THE FUNCTIONALITY OF THE TACHOMETER 12A. CHECK THE INTEGRITY OF THE MOTOR OUTPUT CAPACITORS BY MEGGERING/CHARGE- DISCHARGE METHOD

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
4	LINE SIDE CONVERTER DEVICE SHORTED	<ol style="list-style-type: none"> 1. DEVICE SHORTED BY EXTERNAL MEANS 2. GATE DRIVER DIAGNOSTIC CIRCUIT FAILURE 3. DEVICE FAILURE HAS OCCURRED 4. IMPROPER VOLTAGE FEEDBACK 	<ol style="list-style-type: none"> 1A. CHECK SNUBBER CIRCUIT B. CHECK THE WIRING C. CHECK THE FIBER OPTIC CABLE 2A. CHECK FOR GATE SIGNALS IN TEST MODE 1; IF NO SIGNAL, REPLACE THE BOARDS 3A. CHECK THE RESISTANCE OF DEVICE. REPLACE THE MATCHED SET OF DEVICES IF THE DEVICE READS ZERO OHMS 4A. CHECK THE VOLTAGE FEED BACK CIRCUITS AND RESISTORS
5	MACHINE SIDE CONVERTER DEVICE SHORTED	<ol style="list-style-type: none"> 1. DEVICE SHORTED BY EXTERNAL MEANS 2. GATE DRIVER BOARD FAILURE 3. DRIVE NOT STABLE 	<ol style="list-style-type: none"> 1A. CHECK THE SNUBBER NETWORK B. CHECK THE WIRING C. CHECK THE FIBER OPTIC CABLE 2A. CHECK THE FUSES ON THE IGDPS. REPLACE FUSE, IF BLOWN B. CHECK FOR THE GATING PULSES. IF NO PULSES, REPLACE THE GATE DRIVER BOARD C. CHECK THE POWER SUPPLY BOARD. IF THE POWER SUPPLY READINGS DO NOT ADJUST, REPLACE THE BOARD D. CHECK THE VOLTAGE SHARING RESISTORS 3A. MONITOR MACHINE FLUX SIGNAL AND CHECK FOR OSCILLATIONS IN DRIVE SPEED OR CURRENT AND RE-TUNE IF NECESSARY.
6	NO DISPLAY ON PANEL VIEW	<ol style="list-style-type: none"> 1. PANEL VIEW DEFECTIVE 2. NO POWER SUPPLY 3. NO COMMUNICATION 4. LIGHT BULB IS BURNT OUT. 	<ol style="list-style-type: none"> 1A. CHECK POWER SUPPLY B. CHECK THE CPB HEALTHY LED IS ON C. CHECK THE RIBBON CABLES D. REPLACE PANEL VIEW 2A. CHECK CONTROL POWER SUPPLY 3A. CHECK FOR THE HEALTHY GREEN LED ON COMMUNICATION PROCESSOR BOARD B. CHECK THE CABLE BETWEEN COMMUNICATION PROCESSOR BOARD AND PANEL VIEW C. REBOOT THE PANEL VIEW 4. REPLACE THE BULB.
7	INPUT POWER STAYS ON WHEN ISOLATOR SWITCH IS IN OFF POSITION	<ol style="list-style-type: none"> 1. ISOLATION SWITCH DEFECTIVE 	<ol style="list-style-type: none"> 1A. THE ISOLATION SWITCH BLADES REMAIN ENGAGED WHEN THE SWITCH IS IN OFF POSITION ISOLATE THE POWER FROM INCOMING BREAKER, CHECK THE ISOLATION SWITCH MECHANISM
8	AC CONTROL POWER FAULT	<ol style="list-style-type: none"> 1. LOSS OF AC POWER 	<ol style="list-style-type: none"> 1A. CHECK FOR THE PRESENCE OF CONTROL POWER B. CHECK THE LEVEL OF INCOMING CONTROL POWER SUPPLY >85% C. CHECK THE ANNUNCIATION MODULE D. REPLACE THE ANNUNCIATION

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
9	ADAPTER LOSS WARNING	1. LOSS OF COMMUNICATION	1A. CHECK THE CABLES BETWEEN SCANport ADAPTER AND COMMUNICATIONS PROCESSOR BOARD B. CHECK THE CONTROL VOLTAGE (+12V DC) C. CHECK THE HEALTHY LED ON COMM PROC BOARD D. CHECK WHETHER THE R/I/O ADAPTER IS CONNECTED ON PORT 2 OF THE COMM PROC. E. CHECK THE REMOTE I/O LINK TO PLC
10	BYPASS CLOSED WARNING	1. BYPASS CONTACTOR CLOSED WHEN IT SHOULD BE OPEN 2. CONTACTOR CONTROL POWER NOT PRESENT OR INTERMITTENT 3. OPEN CONTACT IN THE CONTACTOR CONTROL WIRING	1A. CHECK THE I/O MODULES FOR PROPER LEDs ON THE MODULE B. CHECK THE PLC PROGRAM C. CHECK THE FUNCTIONING OF THE VACUUM CONTACTOR 2A. CHECK IF MEDIUM VOLTAGE FEED IS CLOSED. B. VERIFY THAT ISOLATION SWITCH HANDLES ARE ENGAGED C. CHECK THAT NORMAL-OFF-TEST SELECTOR SWITCH IS IN THE PROPER POSITION. D. CHECK THE MEDIUM VOLTAGE POWER AND LOW VOLTAGE CONTROL FUSES. E. CHECK THAT ISOLATION SWITCH AUX. CONTACT ADJUSTMENTS. F. CHECK FOR LOOSE WIRES OR JUMPERS. 3A. RESET DRIVE EMERGENCY STOP. B. CHECK IF EXTERNAL CUSTOMER EMERGENCY STOP/PERMISSIVE CONTACT IS OPEN.
11	BYPASS OPEN WARNING	1. BYPASS CONTACTOR OPEN WHEN IT SHOULD BE CLOSED 2. CONTACTOR CONTROL POWER NOT PRESENT OR INTERMITTENT 3. OPEN CONTACT IN THE CONTACTOR CONTROL WIRING	1A. CHECK THE I/O MODULES FOR PROPER FUNCTIONING B. CHECK THE FUNCTIONING OF THE VACUUM CONTACTOR C. CHECK THE SLC/PLC PROGRAM 2A. CHECK IF MEDIUM VOLTAGE FEED IS CLOSED. B. VERIFY THAT ISOLATION SWITCH HANDLES ARE ENGAGED C. CHECK THAT NORMAL-OFF-TEST SELECTOR SWITCH IS IN THE PROPER POSITION. D. CHECK THE MEDIUM VOLTAGE POWER AND LOW VOLTAGE CONTROL FUSES. E. CHECK THAT ISOLATION SWITCH AUX. CONTACT ADJUSTMENTS. F. CHECK FOR LOOSE WIRES OR JUMPERS. 3A. RESET DRIVE EMERGENCY STOP. B. CHECK IF EXTERNAL CUSTOMER EMERGENCY STOP/PERMISSIVE CONTACT IS OPEN.

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
12	COMM PROC BOARD WARNING	1. FAILURE OF COMMUNICATION	1A. CHECK THE HEALTHY LED ON DCB B. CHECK THE HEALTHY LED ON COMM PROC BOARD C. CHECK THE RIBBON CABLES D. REPLACE THE COMM PROC BOARD
13	DC CONTROL POWER FAULT	1. NO OUTPUT FROM AC/DC POWER SUPPLY 2. LOW DC OUTPUT VOLTAGE	1A. CHECK THE OUTPUT FROM AC/DC POWER SUPPLY, IT SHOULD BE AT LEAST 50V WHEN THE LOAD IS CONNECTED B. DISCONNECT THE OUTPUT LOAD AND VERIFY THE DC VOLTAGE AT POWER SUPPLY C. IF LOAD IS FAULTY, ISOLATE THE LOAD D. CHECK THE CONTROL WIRING 2A. CHECK THE DC OUTPUT VOLTAGE (98% OF 48V). IF THE VALUE IS LOW, A DC CONTROL POWER FAULT IS SIGNALLED. ADJUST THE OUTPUT TO 50.8V. (CALIBRATE INDIVIDUAL MODULES.) B. CHECK THE ANNUNCIATOR CIRCUIT IN THE POWER SUPPLY C. REPLACE THE ANNUNCIATOR BOARD D. CHECK THE LOADING ON THE POWER SUPPLY
14	DRIVE OVERLOAD WARNING / FAULT	1. THE DRIVE OVERLOAD PROTECTION HAS REACHED THE SET VALUE	1A. CHECK THE LOAD FOR ABNORMAL CONDITIONS AND CORRECT. B. THE LOAD MAY BE SLIPPING EXCESSIVELY. TAKE CORRECTIVE ACTION. C. THE TORQUE LIMIT MOTORING IS SET FAR TOO HIGH. VERIFY THE PARAMETER AND SET THE VALUE TO A PROPER VALUE. D. CHECK THE BURDEN RESISTORS
15	FIRMWARE REVISION FAULT	1. FIRMWARE IN THE DCB OR THE COMM PROC BOARD NOT COMPATIBLE	1A. CHECK THE FIRMWARE REVISION LEVELS IN THE TWO DRIVE CONTROL BOARDS WITH THAT OF COMMUNICATION PROCESSOR BOARD AS PER THE COMPATIBILITY CHART AND INSTALL CORRECT VERSIONS
16	GROUND FAULT	1. THE SIGNAL FROM THE GROUND FAULT CT EXCEEDED THE VALUE SET IN THE PARAMETER P171 FOR DURATION SET IN THE PARAMETER P172 2. BURDEN RESISTOR OPENED	1A. CHECK THE LOAD FOR ANY GROUND FAULT. B. MEGGER THE DRIVE, AS PER THE PROCEDURE AND LOCATE THE GROUND FAULT. C. CHECK THE CABLES FROM/TO LINE REACTOR/ISOLATION TRANSFORMER FOR ANY GROUND FAULT AND RECTIFY 2A. CHECK THE BURDEN RESISTOR AND REPLACE IF DEFECTIVE

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
17	INPUT CLOSED WARNING	<ol style="list-style-type: none"> 1. A WARNING INDICATING THAT THE INPUT IS CLOSED WHEN IT IS REQUESTED TO BE OPEN 2. CONTACTOR CONTROL POWER NOT PRESENT OR INTERMITTENT 3. OPEN CONTACT IN THE CONTACTOR CONTROL WIRING 	<ol style="list-style-type: none"> 1A. CHECK THE CONTROL WIRING AND FUNCTION OF CONTROL RELAYS B. CHECK THE INTEGRITY OF DRIVE I/O BOARD C. CHECK THE AUXILIARY CONTACT OF MAIN CONTACTOR D. IDENTIFY ANY PARALLEL PATHS, WHICH MAY BE CAUSING THE VACUUM CONTACTOR TO STAY ON 2A. CHECK IF MEDIUM VOLTAGE FEED IS CLOSED. B. VERIFY THAT ISOLATION SWITCH HANDLES ARE ENGAGED C. CHECK THAT NORMAL-OFF-TEST SELECTOR SWITCH IS IN THE PROPER POSITION. D. CHECK THE MEDIUM VOLTAGE POWER AND LOW VOLTAGE CONTROL FUSE E. CHECK THAT ISOLATION SWITCH AUX. CONTACT ADJUSTMENTS. 3A. RESET DRIVE EMERGENCY STOP. B. CHECK IF EXTERNAL CUSTOMER EMERGENCY STOP/PERMISSIVE CONTACT IS OPEN.
18	INPUT OPEN FAULT	<ol style="list-style-type: none"> 1. INDICATION THAT THE INPUT CONTACTOR HAS OPENED WHEN THE DRIVE IS RUNNING 2. CONTACTOR CONTROL POWER NOT PRESENT OR INTERMITTENT 3. OPEN CONTACT IN THE CONTACTOR CONTROL WIRING 	<ol style="list-style-type: none"> 1A. CHECK THE OPERATION OF VACUUM CONTACTOR AND CHECK THE HOLDING COIL B. CHECK THE CONTROL CIRCUIT C. CHECK THE DRIVE I/O BOARD FOR MALFUNCTION D. CHECK THE RIBBON CABLES. FROM LINE DCB TO I/O BOARD E. CHECK AUXILIARY CONTACTS OF INPUT CONTACTOR 2A. CHECK IF MEDIUM VOLTAGE FEED IS CLOSED. B. VERIFY THAT ISOLATION SWITCH HANDLES ARE ENGAGED C. CHECK THAT NORMAL-OFF-TEST SELECTOR SWITCH IS IN THE PROPER POSITION. D. CHECK THE MEDIUM VOLTAGE POWER AND LOW VOLTAGE CONTROL FUSES. E. CHECK THAT ISOLATION SWITCH AUX. CONTACT ADJUSTMENTS. F. CHECK FOR LOOSE WIRES OR JUMPERS. 3A. RESET DRIVE EMERGENCY STOP. B. CHECK IF EXTERNAL CUSTOMER EMERGENCY STOP/PERMISSIVE CONTACT IS OPEN.

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
19	INPUT OPEN WARNING	1. INDICATION THAT THE INPUT CONTACTOR IS OPENED WHEN IT IS REQUESTED TO CLOSE	1A. CHECK THE OPERATION OF VACUUM CONTACTOR. CHECK "HC" & "CC" B. CHECK THE CONTROL CIRCUIT C. CHECK THE DRIVE I/O BOARD FOR MALFUNCTION D. CHECK AUXILIARY CONTACTS OF INPUT CONTACTOR
20	LINE A/C OVERVOLTAGE FAULT	1. THE LINE VOLTAGE HAS EXCEEDED THE SETTING IN PARAMETER P-165 FOR THE DURATION SET IN P-166	1A. CHECK THE INPUT VOLTAGE AT THE CUSTOMER'S INCOMING AND GET THE TAPS CHANGED ON THE TRANSFORMER IF THE SYSTEM VOLTAGE IS TOO HIGH
21	LINE DC OVERVOLTAGE FAULT	1. THE LINE SIDE DC LINK VOLTAGE IS EXCESSIVE	1A. CHECK THE SETTING FOR DC LINK SIDE VOLTAGE ON PARAMETER P187 AND CHANGE THE VALUE IF REQUIRED, IF THE OTHER PARAMETERS ARE SET PROPERLY B. CARRY OUT A FIRING PULSE CHECK FOR THE LINE SIDE CONVERTER AND MACHINE SIDE CONVERTER THE CHECKS FOR FIRING PULSES FOR SCR/GTO. C. CHECK THE POWER SUPPLY BOARDS D. CHECK TO ENSURE EACH LEG OF THE MACHINE SIDE CONVERTER IS CONDUCTING PROPERLY BY MEASURING THE DC LINK VOLTAGE
22	LINE PARAMETER FAULT	1. THE PARAMETERS STORED IN EEPROM ON THE LINE CONVERTER CONTROL BOARD HAVE BEEN CORRUPTED	1A. CHECK AND CORRECT THE VALUES OF ALL PARAMETER B. CHECK THE +5V POWER SUPPLY AT DCB C. CHECK THE RIBBON CABLE CONNECTIONS D. REPLACE THE LINE DCB IF FAULT PERSISTS
23	LINE REVERSE SEQUENCE WARNING	1. THE DRIVE ATTEMPTED TO MAKE A SYNCHRONOUS TRANSFER WITH REVERSE SEQUENCE LINE VOLTAGE	1A. CHECK THE PHASING ON THE LINE SIDE TO BYPASS AND CORRECT THE SEQUENCE B. CHECK THE SEQUENCE ON THE OUTPUT SIDE OF LINE CONTACTOR AND BYPASS CONTACTOR AND CORRECT THE SEQUENCE
24	LINE SCR OPEN FAULT	1. AN OPEN SCR HAS BEEN DETECTED IN THE LINE CONVERTER	1A. CHECK THE SCR FOR OPEN CIRCUIT B. CHECK THE SNUBBER CIRCUIT AND DIAGNOSTIC RESISTOR C. CHECK THE FIBER OPTIC CABLE D. CHECK THE SCR GATE DRIVER POWER SUPPLY BOARD E. CHECK THE OPTICAL INTERFACE BOARD
25	LINE SELF TEST FAULT	1. THE LINE CONVERTER BOARD HAS FAILED ITS POWER UP TEST	1A. CHECK THE DC POWER AT THE DRIVE CONTROL BOARD FOR THE PRESENCE OF +5V, +15V, -15V B. CHECK WHETHER THE EPROM'S ARE PROPERLY SEATED IN THE SOCKETS C. REPLACE THE DCB IF FAULT PERSISTS

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
26	LINE SYNCH FAULT	1. THE CONVERTER GATING HAS LOST SYNCHRONIZATION WITH THE LINE VOLTAGE	1A. CHECK THE DRIVE GROUNDING FOR PROPER CONNECTIONS B. CHECK THE CONTROL SUPPLY FOR ANY NOISE C. CHECK THE SIGNAL GROUNDS FOR PROPER CONNECTION D. CHECK THE SETTING OF THE COMMUTATION INDUCTANCE PARAMETER
27	LINE UNDER VOLTAGE WARNING	1. THE LINE VOLTAGE IS LOW 2. INPUT VOLTAGE SENSING CORRUPTED 3. LINE DISTURBANCE	1A. VERIFY THE LINE UNDER VOLTAGE SETTING IN THE PARAMETER TABLE AND DETERMINE THE SETTING LEVEL BASED ON THE EXISTING POWER SYSTEM B. CHECK AND RAISE THE TAP ON POWER TRANSFORMER AFTER CONSULTATION WITH THE CUSTOMER 2A. CHECK THE FUSING OF THE TRANSIENT SUPPRESSION NETWORK. B. CHECK THE VOLTAGE FEEDBACK BOARDS FOR ANY OPEN RESISTORS (LINE SIDE). 3A. RESET THE WARNING
28	MOTOR AC OVERVOLTAGE	1. MACHINE SIDE CONVERTER GATING CORRUPTED	1A. CHECK THE GATING SEQUENCE B. CHECK THE FIBER OPTIC CABLES C. CHECK THE FIBER OPTIC INTERFACE BOARD D. REPLACE THE FAULTY GATE DRIVER BOARDS, ISOLATED GATE DRIVER POWER SUPPLY BOARDS, AS DETERMINED E. SET THE EXCITATION LIMIT PARAMETER TO A HIGHER VALUE F. CHECK FOR LOW LINE VOLTAGE
29	MOTOR OVERLOAD	1. TRANSIENT LOADING 2. BURDEN RESISTOR OPEN	1A. ENSURE THAT THE ROTOR IS NOT LOCKED, RESET AND RESTART SET THE TORQUE LIMIT PARAMETER TO A LOWER VALUE 2A. CHECK THE BURDEN RESISTORS
30	RATED RPM WARNING	1. RATED RPM SET TO AN INVALID NUMBER	1A. CHECK THE VALUE OF THE RATED RPM PARAMETER. THE VALUE MAY HAVE BEEN SET TO SYNCHRONOUS SPEED. ENTER THE FULL LOAD RPM AND SAVE IN EEPROM.
31	PULSE NUMBER FAULT	1. PULSE NUMBER HAS CHANGED	1A. CHECK THE PULSE NUMBER PARAMETER AND DEPENDING UPON WHETHER THE DRIVE IS A 6 PULSE OR 12 PULSE SET. THE PROPER VALUE AND SAVE IN EEPROM AND RECYCLE POWER.
32	SPEED COMMAND LOSS	1. DRIVE LOST COMMUNICATION WITH THE DEVICE PROVIDING THE SPEED COMMAND	1A. IF THE SPEED COMMAND IS PROVIDED BY HIM, CHECK THE ADAPTER CABLE BETWEEN COMM PROC BOARD B. IF THE SPEED COMMAND IS FROM REMOTE SOURCE, CHECK THE REASONS FOR LOSS OF COMMUNICATIONS

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
33	NO V_{DC} FEEDBACK	1. HARDWARE	<p>1A. CHECK THE FUSES ON THE MOV'S OF DC LINK SURGE SUPPRESSOR NETWORK (IF PRESENT)</p> <p>B. CHECK THE LINE SIDE VOLTAGE FEED BACK BOARDS FOR ANY DAMAGED COMPONENTS AND REPLACE IF NECESSARY</p> <p>C. CHECK THE CABLING ON THE VOLTAGE FEEDBACK BOARDS FROM THE DC LINK</p> <p>D. CHECK THE RIBBON CABLES FROM THE DRIVE CONTROL BOARD LINE-SIDE TO THE VOLTAGE FEED BACK BOARDS</p> <p>E. DISABLE THE NO VDC FDBK ALARM</p>
34	STALL FAULT	<p>1. MOTOR/LOAD IS JAMMED</p> <p>2. MOTOR IS FREE</p>	<p>1A. CLEAR THE JAM</p> <p>2A. CHECK WHETHER THE DRIVE IS FITTED WITH TACHOMETER OPTION OR NOT. WITHOUT TACHOMETER, THE STALL FAULT IS DETECTED WHEN THE DRIVE REACHES THE COMMANDED SPEED AND THE MOTOR FLUX REMAINS BELOW THE LEVEL SPECIFIED BY PARAMETER FLUX MINIMUM. ENSURE THAT THE MOTOR IS NOT SPINNING AT A HIGHER SPEED THAN THE COMMANDED SPEED OR THE MOTOR IS ROTATING IN THE OPPOSITE DIRECTION. IF THE STALL FAULT OCCURS DURING START UP, THEN THE TORQUE COMMAND MIGHT HAVE BEEN SET TOO LOW. CHECK THE VALUE IN THE PARAMETER TABLE AND INCREASE THE VALUE (APPLICABLE FOR CASES WITHOUT A TACHOMETER).</p> <p>B. WITH THE TACHOMETER OPTION, THE STALL FAULT IS INDICATED ONLY WHEN THE SPEED IS ZERO AND THE DRIVE REACHES THE TORQUE LIMIT, AND IS BELOW 1 HZ AND THE STALL TIME HAS EXPIRED, ENSURE THAT THE TACHOMETER IS FUNCTIONAL.</p> <p>C. CHECK THE MACHINE SIDE CONVERTER CIRCUIT FOR ANY FAILED DEVICES (GTO).</p> <p>D. IF THE STALL FAULT OCCURS DURING START UP, THEN THE TORQUE COMMAND 0 OR 1 MIGHT HAVE BEEN SET TOO LOW. CHECK THE VALUE IN THE PARAMETER TABLE AND INCREASE THE VALUE (APPLICABLE FOR CASES WITHOUT A TACHOMETER).</p> <p>E. IF THE STALL FAULT OCCURS DURING RUNNING, THEN THE TORQUE LIMIT MOTORING MIGHT BE LOW, CHECK AND INCREASE THE VALUE TO SUIT THE APPLICATION.</p> <p>F. EXCITATION LIMIT PARAMETER SET TOO LOW.</p> <p>G. INCREASE THE MOTOR STALL DELAY.</p> <p>H. CHECK THE OUTPUT CAPACITORS.</p>

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
35	MOTOR DOES NOT ROTATE	<ol style="list-style-type: none"> 1. IMPROPER MODE SELECTED 2. MOTOR FAILURE 3. MV SENSING NOT AVAILABLE TO THE DRIVE CONTROLS 4. FAILURE OF TACHOMETER 5. THE STOP SIGNAL IS AT LOW LEVEL FROM CUSTOMER'S PLC 6. FAILURE OF MOTOR CAPACITOR 	<ol style="list-style-type: none"> 1A. CHECK THE MODE OF OPERATION FROM THE PARAMETER TEST MODE AND SET IT TO ZERO, WHICH IS THE NORMAL MODE OF OPERATION 2A. MEGGER THE MOTOR AND DETERMINE THE CONDITION 3A. CHECK THE VARIABLE V_{LINE} AND IT SHOULD READ AROUND 1.0 PU. DETERMINE THE CAUSES AND RECTIFY. 4A. THE PANEL VIEW MAY INDICATE THAT THE DRIVE IS RUNNING WHEN THE MOTOR IS NOT ROTATING, CHECK THE FUNCTIONING OF THE TACHOMETER 5A. CHECK THE STATUS VARIABLE LOGIC COMMAND WORD OR STOP OWNER VARIABLE AND RECTIFY. 6A. CHECK THE MOTOR FILTER CAPACITORS FOR ANY SHORTING
36	OVER TEMPERATURE 1 THROUGH 7.	<ol style="list-style-type: none"> 1. OPEN THERMISTOR 2. OPEN FEED BACK CIRCUIT 3. FAN FAILURE 4. FAILED RECEIVER CIRCUIT 	<ol style="list-style-type: none"> 1A. CHECK THE THERMISTOR ON THE MACHINE SIDE CONVERTER STACK 2A. CHECK THE POWER TO THE THERMISTOR FEED BACK BOARD CHECK THE FIBER OPTIC CABLE FROM THE THERMISTOR FEED BACK BOARD TO THE OPTICAL INTERFACE BOARD 3A. CHECK FOR THE CORRECT FAN OPERATION B. CHECK FOR PROPER VENTILATION 4A. CHECK THE RECEIVER CIRCUIT ON THE OPTICAL INTERFACE BOARD AND REPLACE THE BOARD IF NECESSARY
37	NO READY LIGHT	<ol style="list-style-type: none"> 1. NO MEDIUM VOLTAGE 2. BLOWN FUSE ON SURGE SUPPRESSION NETWORK 3. LOW LINE VOLTAGE. 	<ol style="list-style-type: none"> 1A. CLOSE THE INPUT ISOLATOR B. CHECK THE POWER SUPPLY FROM CUSTOMER SIDE C. INPUT CONTACTOR CONFIGURED AS NORMALLY OPEN 2A. CHECK THE FUSES ON THE SURGE SUPPRESSION NETWORK B. CHECK THE MOV'S INTEGRITY AND REPLACE THE DEFECTIVE MOV C. CHECK THE V_{LINE} VARIABLE, IT SHOULD READ 1.0 P.U. D. SCOPE THE WAVEFORM AT V_{12}, V_{23}, V_{31} ON LINE SIDE DRIVE CONTROL BOARD FOR PROPER SHAPE 3. VERIFY V line AND ENSURE PROPER VOLTAGE TO DRIVE.

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
38	HARDWARE OVER CURRENT	<ol style="list-style-type: none"> 1. CT POLARITY / CONNECTIONS TO GROUND 2. BURDEN RESISTOR DEFECTIVE 3. PARAMETERS ARE NOT PROGRAMMED PROPERLY. 	<ol style="list-style-type: none"> 1A. CHECK THE CT's FOR PROPER POLARITIES AS PER THE DRAWING B. CHECK THE GROUNDING AT CTS AND ENSURE THEY ARE FIRM 2A. CHECK THE BURDEN RESISTOR FOR OPEN CIRCUIT. REPLACE IF REQUIRED. B. CHECK THE RIBBON CABLE FROM PHOENIX CONNECTOR TO LINE SIDE DRIVE CONTROL BOARD 3A. THE EXCITATION LIMIT IS SET TO LOW. INCREASE THE VALUE TO 1.5 TIMES ($1/L_{mag}$ measured) B. THE FLUX REGULATOR BANDWIDTH IS SET HIGH. REDUCE THE BANDWIDTH.
39	12P PHASING	<ol style="list-style-type: none"> 1. INCORRECT PHASE ROTATION FROM INCOMING POWER SUPPLY TO DRIVE. 	<ol style="list-style-type: none"> 1A. APPLY MV TO DRIVE AND MEASURE THE PHASE DIFFERENCE BETWEEN V_{12} AND V_{23} ON THE LINE DCB. V_{12} SHOULD LEAD V_{23} BY 120: MEASURE V_{12} AND V_{31} ON LINE DCB, V_{12} SHOULD LEAD BY 240: IF NOT CORRECT, SWAP ANY 2 PHASES ON THE PRIMARY SIDE OF THE ISOLATION TRANSFORMER. RECHECK MEASUREMENTS. B. PERFORM CONTINUITY CHECKS ON CABLES BETWEEN ISO XFORMER AND DRIVE, ENSURE THE DELTA A OF ISO XFORMER IS CONNECTED TO DELTA A OF DRIVE AND SO FORTH.
40	DRIVE UNSTABLE	<ol style="list-style-type: none"> 1. CHECK THE OUTPUT VOLTAGE/CURRENT WAVEFORMS 	<ol style="list-style-type: none"> 1A. SCOPE THE OUTPUT VOLTAGE AND CURRENT WAVEFORMS AND CHECK THE VOLTAGE AND CURRENT FEEDBACK. B. CHECK THE VFB FOR ANY OPEN RESISTORS. C. CHECK THE INTEGRITY OF GROUNDING IN THE DRIVE AND EXTERNAL GROUNDING.
41	NEUTRAL OVER VOLTAGE FAULT	<ol style="list-style-type: none"> 1. NEUTRAL GROUND VOLTAGE HAS EXCEEDED THE VALUE SET IN PARAMETER P189 FOR THE DURATION SET IN PARAMETER P190. 2. CHECK OUTPUT CAPACITORS 	<ol style="list-style-type: none"> 1A. CHECK THE MOTOR WINDING INSULATION TO GROUND. B. MEGGER THE CABLES FROM DRIVE OUTPUT TO MOTOR, AS PER PROCEDURE. C. CHECK THE OUTPUT GROUNDING NETWORK IN THE DRIVE. D. CHECK THE ISOLATION TRANSFORMER WINDINGS AND THE CABLES TO THE DRIVE WITH A MEGGER. 2A. CHECK THE INTEGRITY OF THE CAPACITORS.

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
42	RATED I FEEDBACK WARNING	1. THE CURRENT FEEDBACK SCALING IS OUT OF RANGE	1A. CHECK THE PARAMETER AND ENSURE PROPER VALUES ARE ENTERED FOR C. T. RATIO. (P149) C. T. LINE BURDEN (P151). B. CHECK THE PARAMETERS AND ENSURE PROPER VALUES ARE ENTERED FOR LEM RATIO (P150) AND C. T. MOTOR BURDEN RESISTOR (P152).
43	TACH ROTATION WARNING	1. THE TACH FEEDBACK SIGNALS FROM PHASE 'A' AND PHASE 'B' INTERCHANGED	1. CHECK THE CABLING FROM TACHOMETER TO DRIVE AND CORRECT THE WIRING.
44	MOTOR OVERSPEED	1. LOSS OF LOAD	1A. CHECK THE APPLICATION AND CHANGE THE SPEED REGULATOR BANDWIDTH. B. CHECK THE PARAMETER (P185) FOR MOTOR OVERSPEED TRIP AND INCREASE THE VALUE AS REQUIRED BASED ON THE APPLICATION.
45	LINE HARDWARE WATCHDOG MOTOR HARDWARE WATCHDOG	1. DRIVE CONTROL BOARD HARDWARE FAILURE 2. DEFECTIVE EPROMs	1A. REPLACE DRIVE CONTROL BOARD B. ENSURE THAT EEPROM'S ARE INSTALLED CORRECTLY IN CORRECT SOCKETS (EEPROM'S INSERTED BACKWARDS WILL NO LONGER BE USABLE) 2A. REPLACE EEPROMs
46	LINE SOFTWARE WATCHDOG, MOTOR SOFTWARE WATCHDOG	1. DRIVE CONTROL BOARD HARDWARE FAILURE 2. FIRMWARE BUG	1A. REPLACE DRIVE CONTROL BOARD B. RESET FAULT AND RESTART 2A. IF FAULT PERSISTS, ASK FACTORY IF FIRMWARE UPDATE WILL ELIMINATE PROBLEM
47	LINE SOFTWARE OVERCURRENT, MOTOR SOFTWARE OVERCURRENT, MOTOR HARDWARE OVERCURRENT	1. OVERCURRENT TRIP PARAMETERS SET TOO LOW RELATIVE TO TORQUE LIMIT 2. CURRENT REGULATOR IN LIMIT 3. FLUX REGULATOR IN LIMIT 4. SHORTED THYRISTORS	1A. OVERCURRENT TRIP PARAMETERS SHOULD BE INCREASED IF TORQUE LIMIT INCREASED ABOVE DEFAULT SETTING. 2A. IF LINE FIRING ANGLE IS STUCK AT ADVANCE LIMIT (8 DEGREES), CURRENT CONTROL MAY BE LOST. INCREASE LINE VOLTAGE OR DECREASE MOTOR FLUX COMMAND. 3A. IF MAGNETIZING CURRENT (LX) COMMAND IS STUCK AT EXCITATION LIMIT, CONTROL OF MOTOR VOLTAGE IS LOST. INCREASE EXCITATION LIMIT PARAMETER 4B. RESTART DRIVE TO ALLOW STARTUP DIAGNOSTICS TO DETECT ANY SHORTED THYRISTORS.

#	FAULT / ALARM	PROBABLE CAUSE	RECOMMENDED ACTION
48	DRIVE RUNS AT LESS THAN COMMANDED SPEED	<ol style="list-style-type: none"> 1. SPEED REGULATOR IN TORQUE LIMIT 2. CURRENT REGULATOR IN LIMIT 	<ol style="list-style-type: none"> 1A. DECREASE LOAD 1B. INCREASE TORQUE LIMIT PARAMETER (DRIVE MAY TRIP ON OVERLOAD) 2. IF LINE FIRING ANGLE IS STUCK AT ADVANCE LIMIT (8 DEGREES) DC LINK VOLTAGE IS AT MAXIMUM. INCREASE LINE VOLTAGE OR DECREASE MOTOR FLUX COMMAND.
49	PANELVIEW COMMUNICATIONS ERRORS	<ol style="list-style-type: none"> 1. LOSS OF DRIVE CONTROL POWER 2. 5 VOLT-DC OUTPUT ON DC\DC CONVERTER OUT OF TOLERANCE, LEVELS BELOW 4.6 VOLT WILL CAUSE DCBs TO CRASH 3. 15 VOLT-DC OUTPUTS ON DC\DC CONVERTER OUT OF TOLERANCE 	<ol style="list-style-type: none"> 1. CORRECT CAUSE FOR LOSS OF CONTROL POWER 2. REPLACE DC\DC CONVERTER 3. REPLACE DC\DC CONVERTER

External Fault Configuration

This is a detailed explanation for setting the Fault Class of the configurable external fault/warnings.

There are 16 configurable external fault/warnings. The first eight external fault inputs 1 to 8 are hard wired into the digital I/O circuit boards. Inputs 1 to 3 are located on digital I/O board #1, and inputs 4 to 8 are located on the optional digital I/O board #2. External faults 9 to 16 are read into communication processor board (CPB) via a SCANport adapter.

Under the "SETUP" soft key directory you will find two headings, FAULTS and EXTERN. "Extern" is a listing of the external fault labels. The default labels for the external faults are the numbers 512 through 527, with 512 representing config. fault / warning #1, and 527 represents config. fault / warning #16. Change any of the utilized external faults / warnings to reflect the particular piece of equipment providing the input (if not already done).

Under "Faults" you have the ability to enable or disable almost all drive faults. Specific external faults can be turned on or off by setting their values to "off" or "on". "Off" causes the protection and messaging to be turned off.

Under "P Options" the Ext. Flt. Class 1 and 2 parameters are available. These are four digit hex numbers with each individual hex digit representing four individual config. faults. The four digit hex number (e.g. FFFF) can be decoded into 16 binary bits which correspond to the 16 configurable fault / alarms (1 to 16, right to left), as indicated.

Recall:	<u>BIN</u>	=	<u>HEX</u>		<u>BIN</u>	=	<u>HEX</u>
	0001	=	1		1010	=	A
	0010	=	2		1011	=	B
	0011	=	3		1100	=	C
	0100	=	4		1101	=	D
	0101	=	5		1110	=	E
	0110	=	6		1111	=	F
	0111	=	7				
	1000	=	8				
	1001	=	9				

Config. Fault / Warning	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
External Fault Class 1 "hex."			X			X				X				X		
External Fault Class 1 "bin."	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
External Fault Class 2 "hex."			X			X				X				X		
External Fault Class 2 "bin."	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

where: "X" represents a hexadecimal digit and "x" represents a binary bit.

Note: The horizontal position of the binary bits corresponds to the specific **config. fault / warning** located directly above the particular bit.

The class of a particular **config. fault / warning** is determined by the combination of both of the External Fault Class parameter's bits.

The factory default for the variable “**External Fault Class 1**” is 0000 hex and the default value for “**External Fault Class 2**” is FFFF hex, therefore, the default class for all the **config. fault / warning** input is **class 2** “ramp down trip”.

If both, External Fault Class 1 and 2 parameters were set to 0000 hex all of the 16 **config. faults / warnings** would be **class 3** “warnings”.

If External Fault Class 1 was set to FFFF hex regardless of the value of External Fault Class 2, all of the **config.fault / warnings** would be **class 1** “immediate trips”.

Note: Several values for External Fault Class 1 and 2 will produce the same result due to the way a class 1 fault is determined and whether or not the particular faults are turned off.

Included is an insert from the manual that includes the External Fault Class 1 and 2 parameter descriptions.

External Fault Class 1 [Ext flt class 1]

Linear number: 230
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Default value: 0000 Hex

This parameter specifies which of the external faults are Class 1 faults. It is bit encoded the same as parameter “External Fault Input”.

This parameter and the following parameter taken together specify the class of each of the 16 external faults as shown in the following table:

Class	Ext Flt Class 1	Ext Flt Class 2
1	1	0 or 1
2	0	1
3	0	0

Note: Class 1 faults cause the drive to trip immediately. Class 2 faults cause the drive to decelerate to a stop at the normal ramp rate before tripping. Class 3 faults are only warnings and cause no action to be taken.

External Fault Class 2 [Ext flt class 2]

Linear number: 231
 Minimum value: 0000 Hex
 Maximum value: FFFF Hex
 Default value: FFFF Hex

This parameter specifies which of the external faults are Class 2 faults. It is bit encoded the same as parameter “External Fault Input”. For more information refer to the description of the previous parameter.

Example:

Consider an application, which utilizes only the config. fault inputs 1, 2, 3, 5, and 6. The requirements are:

- Inputs 1, 3 and 6 are to be ramp down trips “class 2”.
- Input 5 is desired to be an immediate trip “class 1”.
- Input 2 is to be only a warning “class 3”.

1. Enable or disable the utilized config. fault / warnings by going into “**Setup**” then into “**FAULTS**” and setting the appropriate inputs to either “on” or “off”.
2. Place an x “don’t care” into all of the bit locations corresponding to the bits of the disabled config. fault / warnings as required.

Config. Fault / Warning	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Ext fkt class 1	X	X	X	X	X	X	X	X	X	X			X			
Ext fkt class 2	X	X	X	X	X	X	X	X	X	X			X			

3. Place a 1 or a 0 into the bit locations of both of the External Fault Class parameters to obtain the desired class of fault. Note: you may place all 0’s into the External Fault Class 2 bit locations corresponding to class 1 faults (Ext. fkt. Class 2 bit 5 in this example). See below:

Config. Fault / Warning	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Ext fkt class 1	X	X	X	X	X	X	X	X	X	X	0	1	X	0	0	0
Ext fkt class 2	X	X	X	X	X	X	X	X	X	X	1	0	X	1	0	1

4. To simplify the solution, set all of the X’s to 1.

Ext fkt class 1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0
Ext fkt class 2	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1

5. Convert the individual 4 digit binary values to hex. values using the table shown above

Ext. fkt. class 1																
“binary value”	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	0
“hex value”	F				F				D				8			
Ext. fkt. class 2																
“binary value”	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	
“hex value”	F				F				E				D			

Therefore setting Ext. fkt. class 1 = FFD8 hex, and Ext. fkt class 2 to FFED hex would achieve the desired faults classes for the external inputs.

Please confer with the customer in regards to their desired classes for their specific fault inputs and set the hex values accordingly.

Consult the factory if fault classes for specific Allen-Bradley equipment are not known.

NOTE: Spare parts for Drives vary depending on voltage ratings, rectifier configurations and cooling systems.

A complete Spare Parts list is provided in the final instruction binder shipped with each order.

Contact Cambridge Product Support Parts Division (519-740-4790) for information on spare parts for your particular Drive. Please include your order number. Order number can be found on the Drive's nameplate located in the control section, or on the Drive's electrical wiring diagram.

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